POWER

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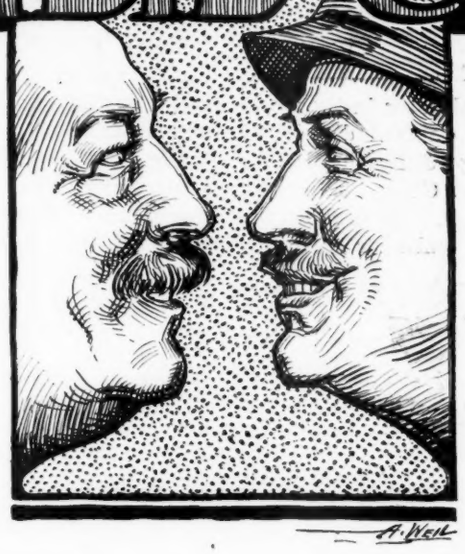
CANDID CHAT

THE BOSS



"That's a fine new car the Boss has," remarked Smith to Brown, as the superintendent of motive power dashed up to the plant in a massive touring car. "Just a minute," added Smith; "you don't have to snatch that oil can down from its resting place and run paths around this equipment just because the Boss is coming. He has already got your size and number, and you're not putting any dead moss on his eagle eyes by jumping every time he drops around."

"I don't know about that," growled Brown; "what he don't know won't hurt him any."

"Well, maybe not," replied Smith, "but did you ever study the Boss a little bit?" "Sure," replied Brown, "I've studied him enough to know he has a great big snap of a job and a $3000 car to travel back and forth to said snap."

"Is that all?" asked Smith. "Well, that's enough, isn't it?" snapped Brown. "He don't have to get out here till 8 or 9 A.M. I have to come at 7 A.M. or be docked. I ride the street cars or walk—I climb around these big hot engines while he sits in his glass office with a 12-in. electric fan going full speed and has an office boy to wait on him. If I stay home on Sunday, I lose a day's pay. He comes out Sunday noon, looks around, drops an order here and there, and buzzes away for an afternoon joy ride. I guess he's afraid we will get a bit o' rest on Sunday if he don't show up to prod us along," mused Brown.

"Well," remarked Smith, "I don't believe you know the Boss as well as you think you do. He comes out here at 9 A.M., just as you say, and holds a ten-minute consultation with his first assistant, his master mechanic and his foreman of repairs—each one of these fellows has a condensed report for the Boss covering their respective positions. Next he makes out a condensed report, taken from our various log sheets, for the general superintendent. Maybe he has an armful of blueprints to familiarize himself with, maybe some of we younger fellows are called in on the carpet—not to get a hair-raising calling, but to get a bit of the kindest fatherly advice a man ever got.

"How many times have you seen him go out to lunch at 1:30 P.M. because he didn't notice that massive whistle at noon? How many times have you seen him stay out here night and day on some special work that demanded immediate results? Who, around here is more ready with a substantial loan to the boys in case of sickness or death in a family? Who is it that sees all the loopholes in our organization and safety-first propaganda? Who is it that did so much to launch your Employees Club? Who is it that donates in three figures every year to the Volunteer Nurses' Expenses? And another thing—Do you know who started that collection for your wife some time ago, when she had to have a specialist's services in order to save her life? Do you know who paid for those good Havanas we all got last Christmas? Do you know who cut out the 24-hour change shift you used to howl about? Let me tell you, the Boss knows the possibilities of every man that works under him and governs himself accordingly. Did you ever notice that he covers more territory and does it in less time than any other man on the job? And did you ever stop to think that this 100,000-hp. station hasn't had a shutdown in five years and that the general efficiency of the plant is 22 per cent. better than it was when he came here six years ago?"

The above conversation took place nearly five years ago in a large central station where Smith was an operating engineer. Brown is still pump engineer and still growling about his rut in life. The "Boss" is now general superintendent, the station has a 20,000-h.p. addition to it, 8-hour shifts for the boys in overalls, and better wages. Smith? Oh, yes, he drives a fine large touring car to and from work now; he owns a home out near the shore, where a junior Smith waxes all smiles when he hears the honk! honk! of his dad's car.

Fall into a legacy? Sure he did—a legacy of ambition backed by inclination and adaptability willed to him early in life. You see, Smith is the "Boss" now.

Contributed by Albert L. Fritz.

Power Plant Calumet Terminal Elevator

BY THOMAS WILSON

A 5386-kv.-a. turbine plant designed to meet the needs of the world's largest elevator. Automatic operation and control is a feature. With solenoid oil switches under remote control and motor-operated rheostats, the turbines, once started, may be operated by one man from the bench-board, where the instruments and control devices are centered.

THE LARGEST single grain elevator in the world is now being erected in the Calumet district of South Chicago by the Chicago & North Western Railway Co., to lease to the Armour Grain Co. It will be the last word in elevator design. At present the elevator has 223 immense concrete tanks for receiving, drying and storing the grain, its capacity being 6,500,000 bushels. An addition of 78 storage tanks within the next two years will increase the capacity to 10,000,000 bushels. Four-story steel-structure operating houses erected on top of the tanks will contain the conveying, drying and separating machinery. In addition there is a marine-tower shipping gallery and tower, and the dock front on the Calumet River where there are facilities for two 600-ft. boats at one time. The structures are fireproof throughout, and as a safeguard against overheating, the Zeleny thermometric system has been installed to indicate tank temperatures at 10-ft. intervals of height. Rail service will be good, as the elevator is near the main lines of several railways and through the belt system can readily communicate with all the roads entering Chicago.

Besides the elevator proper, there will be shop and office buildings, a dust-sacking house, a bleacher plant, a welfare building and a power plant to furnish light, heat, power and steam. In line with recent developments it is the desire of the company leasing the property to make conditions for the employees as comfortable and convenient as possible. The welfare building has sleeping quarters, private and general dining rooms, kitchen, refrigerating plant, a reading and lounging room and the usual shower baths, toilets and lockers.

Fig. 1 is a general view of the elevator while under construction, the power-plant building being in the foreground. Work on the latter was started June 1, 1916, by Westinghouse Church Kerr & Co., who designed and constructed the building and installed the equipment. The building is a brick and steel structure resting on a pile foundation with a concrete cap. In plan it measures 80 x 125 ft. and to the peak of the monitor roof over the boiler room is 87 ft. high. The construction is fireproof and substantial without frills. The floors are of reinforced concrete, the interior walls are painted, and the exterior is built up of red pressed brick. The roof consists of bars covered with 3-ply built-up asbestos roofing. The Van Ness system of ventilation is employed. The use of the gypsum "pyro" bar blocks prevents condensation in the under side of the roof slab. Besides supplying light and power, the plant is designed to furnish 40,000 lb. of steam per hour

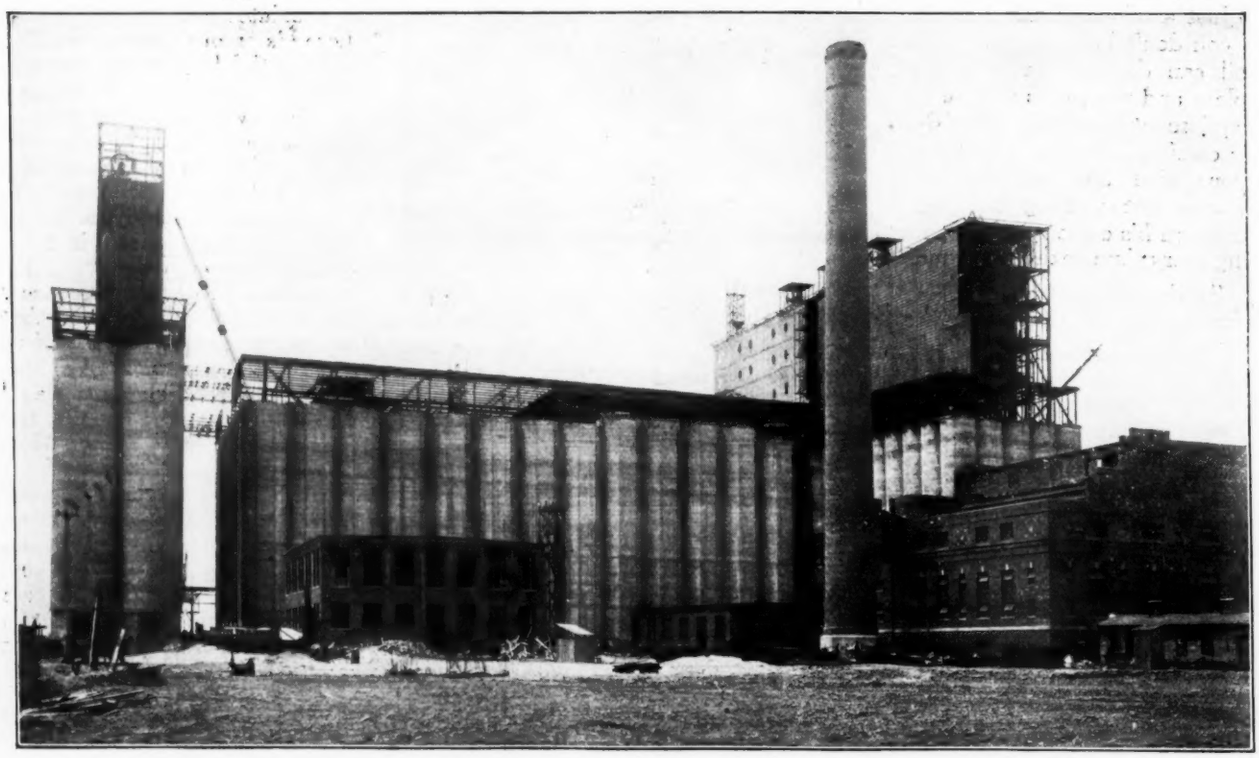
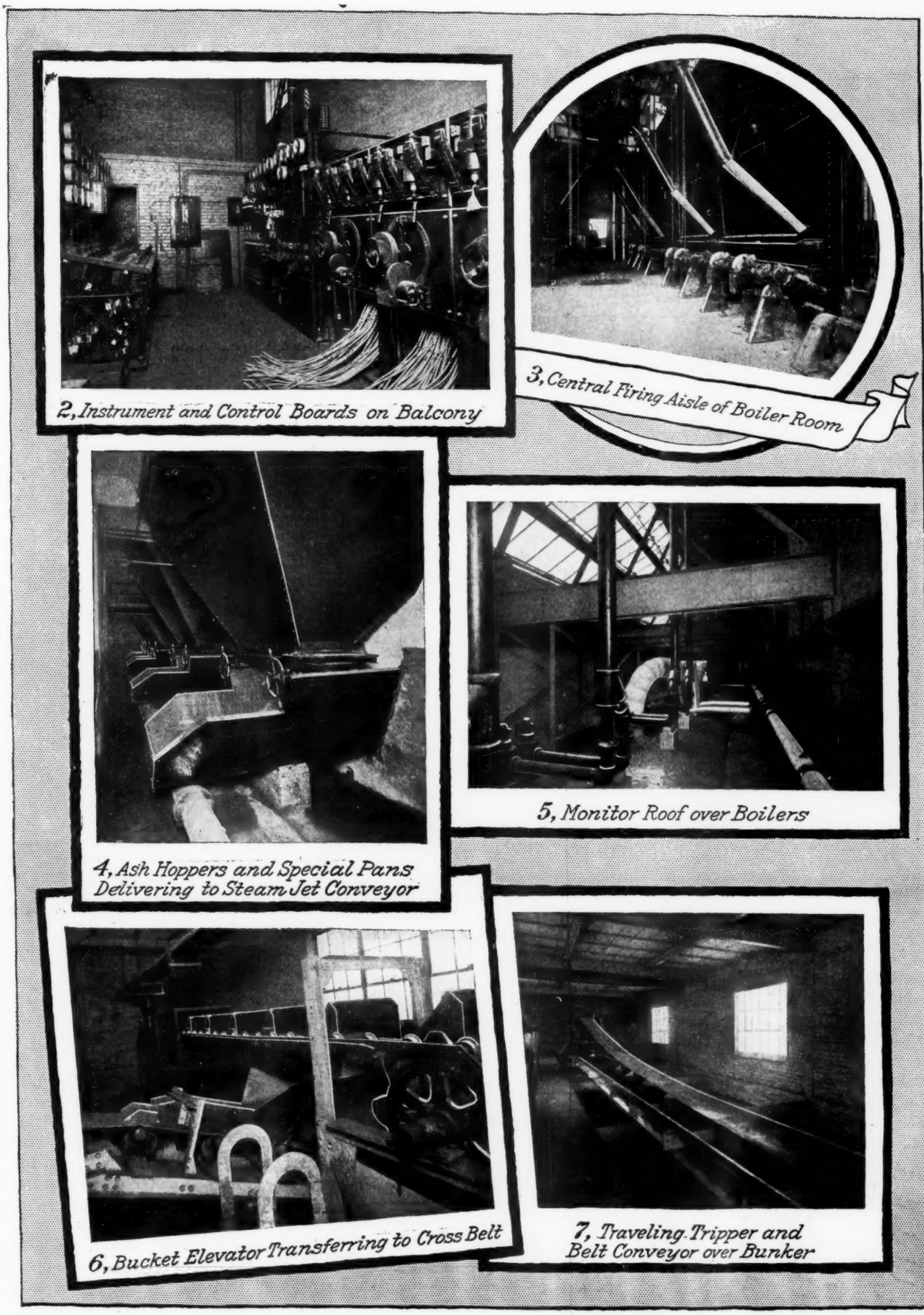


FIG. 1. CALUMET TERMINAL ELEVATOR TO HAVE A CAPACITY OF 10,000,000 BUSHELS


2, Instrument and Control Boards on Balcony
3, Central Firing Aisle of Boiler Room
4, Ash Hoppers and Special Pans Delivering to Steam Jet Conveyor
5, Monitor Roof over Boilers
6, Bucket Elevator Transferring to Cross Belt
7, Traveling Tripper and Belt Conveyor over Bunker

FIGS. 2 TO 7. SOME VIEWS OF CALUMET TERMINAL ELEVATOR PLANT EQUIPMENT

for grain-drying purposes. The steam is reduced from boiler pressure to 100-lb. gage and a desuperheater removes the superheat to guard against the danger of fire which might occur if high-pressure superheated steam should be used. As the prime movers operate condensing, live steam for heating, reduced to suitable pressures, will be used. Condensation in both cases is brought back to the power plant.

The boiler room contains six Stirling boilers, each having 5020 sq.ft. of heating surface and a superheater designed to add 150 deg. to the steam temperature, the operating pressure being 200 lb. gage. There is space for two more units, and these may be of larger capacity. The boilers are arranged two per battery on both sides of a central firing aisle. They are fully equipped with coal- and ash-handling machinery, six-retort underfeed stokers, each having 99 sq.ft. of effective grate area, and U-multiple differential draft gages to indicate the draft in the air boxes, over the fire and at the uptake. The gage is located on the boiler front in plain sight of the firemen. Operation has been made as nearly automatic as possible, reducing labor requirements to a minimum, and the same plan has been followed in the turbine room. A commendable feature is the provision of the monitor roof over the boilers, giving an abundance of light and space as shown in Fig. 5, and providing for ventilation.

It has been estimated that each boiler setting contains 40,000 brick, of which 10,000 are firebrick. Setting the mud drum 6 ft. off the floor gives a large combustion chamber in which the usual furnace arch is omitted. Otherwise the setting is standard. The breeching back of each row of boilers enters at right angles a common flue running straight to an exterior stack. The latter is built of radial brick. It is 203 ft. high above the boiler-room floor and at the top is 12 ft. diameter, giving an area of 113 sq.ft. as compared to 133 sq.ft. for the breeching. Per 1000 sq.ft. of boiler-heating surface these areas reduce to 20 sq.ft. of grate, 4.4 sq.ft. of breeching and 3.8 sq.ft. of stack.

When burning Illinois coal of 12,000 B.t.u., the stokers will be capable of forcing the boilers to 200 per cent. of rating. Vertical engines on the boiler-room floor drive the stokers through silent chain drives to the stoker shaft in the basement and a sprocket chain drive to the individual stoker. Pressure regulators control the speed of the engines and therefore the rate of burning. Air is supplied to the stokers by three forced-draft fans, turbine-driven through reduction gearing. Pressure regulators on the turbines control the quantity of air.

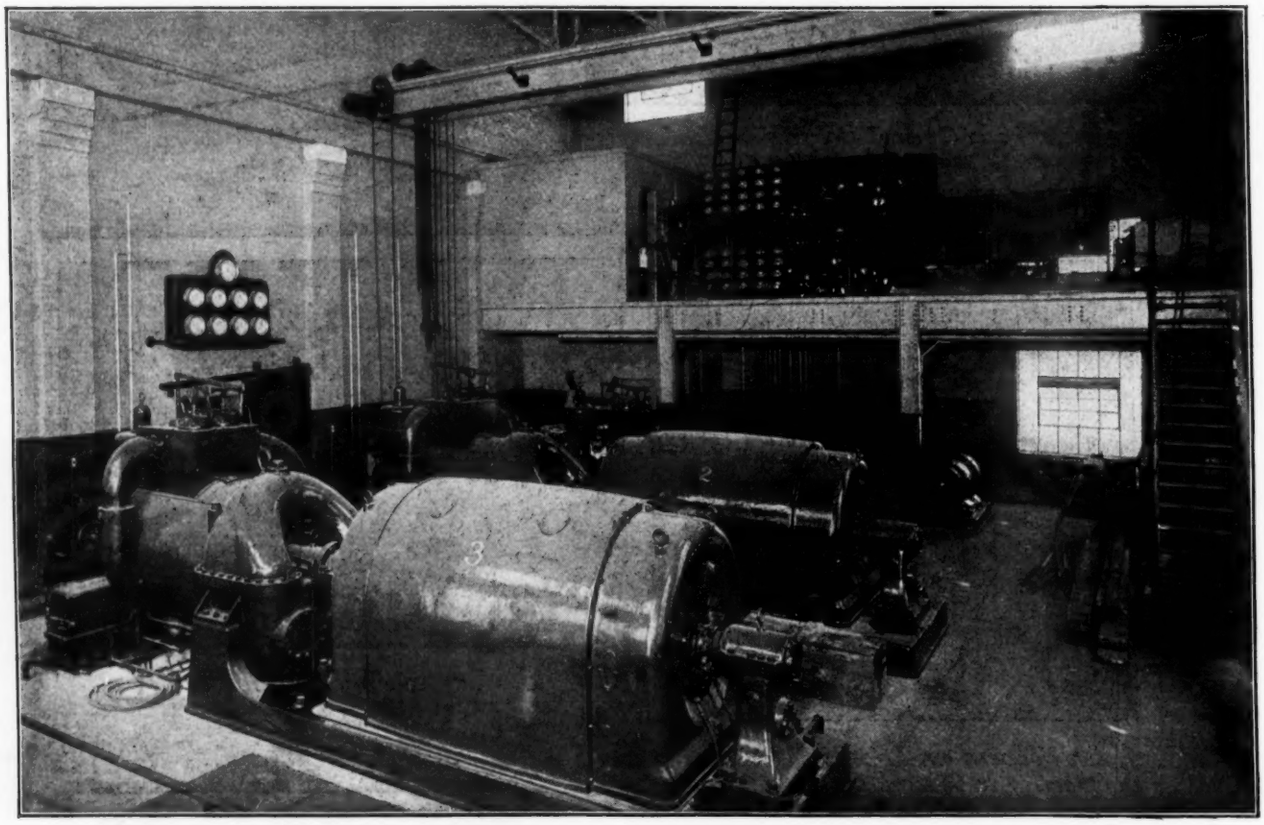


FIG. 8. GENERAL VIEW OF TURBINE ROOM, CALUMET ELEVATOR PLANT

Coal for the plant arrives in bottom-dump cars, which empty into a track hopper. A shaking feeder underneath passes the coal to a two-roll crusher, and from here a 24-in. belt conveyor transfers it to the boot of a bucket elevator, the latter elevating it to the top of the boiler room, where it is transferred to a cross-bolt equipped with an automatic tripper running over the coal bunker of 600 tons' capacity. On its way to the furnace the coal passes through individual chutes flaring at the ends to the size of the stoker hopper. The conveying equipment will deliver coal at the rate of 60 tons per hour. It is driven by vertical engines because the exhaust steam will be needed to heat the

feed water and it is desirable to keep this equipment independent of the engine room, as drying may be required when the generators are shut down. Plans for reserve coal storage of 2000 tons are now under consideration. It is proposed to construct additional track hoppers, which will deliver into a bucket elevator, the latter discharging into an overhead hopper with chutes leading in opposite directions to guide the coal into concrete bunkers on either side. Under the bunkers will be belt conveyors connecting with the power-plant system.

Ashes are handled by a vacuum steam-jet system made up of 8-in. pipe. There is a separate conveyor for each row of boilers, both discharging into an overhead tank of 1000-cu.ft. capacity which empties into railway cars on the coal track. The system will handle 8 tons of ash per hour. Fig. 4 shows the special ash pans which guide the ashes from the hoppers under the stokers into the suction pipe of the conveyor. A 1-in. nozzle in each pipe pulls the ashes through a horizontal run of 60 ft. and forces them up from the basement to the top of the ash tank, an elevation of about 90 ft. Soot from the boilers is also carried away by these conveyors.

Both city and river water enter the plant, the former ordinarily for house purposes and the Calumet River water for condenser cooling and boiler feed. The city water is received in a surge tank from which there are suction connections to the various pumps. Two direct-acting house pumps, cross-connected, raise the pressure of the water to 100 lb. so that it will reach the highest service point in the elevator. Reducing valves lower the pressure for the lower buildings and the power plant. Fire pressure is 150 lb., and an independent system of mains and hydrants and the usual underwriters' fire pump are installed, the steam end being specially designed for use with 200-lb. pressure and 150-deg. F. superheat.

River water for the condensers enters the plant through a 36-in. flume and is returned to the river through an independent main of the same size. From the discharge well of the condensers the condensate is delivered to the feed-water heater by motor-driven hotwell pumps. Service water is elevated by the service pumps to a 2000-gal. open tank in the monitor roof of the boiler room. The tank maintains a head pressure on the service-pump governors approximating 35 lb. and so steadies the action of the pumps that their operation is practically continuous. Under float control makeup water from the tank is admitted to an open heater and then passes through an independent V-notch meter to the feed pumps. Of the latter there are two four-stage turbine-driven centrifugals, each having capacity to deliver 384 gal. per min. against a 520-ft. head. The pumps are cross-connected, and either has sufficient capacity to supply the boilers. They are used interchangeably for boiler feeding or washing. Pump governors control the feed, which passes to the boilers through a loop system of cast-iron pipe, with brass leads to the boilers.

Steam from the boiler outlets passes through loops to the superheater and then out through stop and check valves to an 8-in. header back of each row of boilers. Connections drop to the basement to 6- and 8-in. mains supplying the pumps and turbines respectively.

In the turbine room there are three units, all generating three-phase 60-cycle current at 600 volts. The speed in each case is 3600 r.p.m. Two of the machines are rated at 2308 kv.-a., and the smaller has a capacity of 770 kv.-a. The hydraulic air pumps of the jet condensers are turbine-driven through reduction gearing, the ratio for the larger units being 3600 to 720 and for the smaller, 5000 to 670. To serve these machines there are two exciters, each of 50-kw. capacity, one being turbine-driven and one a motor-generator.

A 12½-kw. motor-generator set is furnished for charging the storage batteries. The last-named and one of the exciters are driven by induction motors and the other 50-kw. machine by a steam turbine through reduction gearing. The two exciters alternate and

PRINCIPAL EQUIPMENT OF POWER PLANT OF CALUMET TERMINAL ELEVATOR

No.	Equipment	Kind	Size	Use	Operating Conditions	Maker
6	Boilers	Stirling water-tube	502-hp.	Steam generators	200 lb. press., 150 deg. superheat	Babcock & Wilcox Co.
6	Stokers	Underfeed	6-retort, 99 sq.ft.	Serve boilers	Driven by Westinghouse Junior engines	Westinghouse Elec. & Mfg. Co.
6	Superheaters	Babcock & Wilcox		Serve boilers	150 deg.	Babcock & Wilcox Co.
6	Soot blowers	Vulcan	No. 3 system	Serve boilers	5-pipe style	G. L. Simonds & Co.
3	Fans	Conoidal	No. 5½	Forced draft	Driven by Westinghouse turbine and reducing gear	Buffalo Forge Co.
1	Chimney	Radial-brick	12-ft. diam., 203 ft. high	Serve boilers		Alphons Custodis Chimney Construction Co.
2	Pumps	Centrifugal	5-in., 4-stage	Boiler-feed pumps	520 gal. per min. at 2,530 r.p.m. against 520 ft. head	Manistee Iron Works
2	Turbines	Horizontal	75 h.hp.	Drive feed pumps	2,500 r.p.m.	Kerr Turbine Co.
1	Heater	Open	200,000 lb. per hr.	Heat feed water	Exhaust steam from aux.	Hoppes Mfg. Co.
1	Meter	V-Notch	Class R	Measure feed water	Weigher, recorder and indicator	Hoppes Mfg. Co.
2	Pumps	Duplex	7½x5x6 in.	House	Deliver at 100 lb. press.	Deane Steam Pump Co.
1	Heater	Hot-water inclosed	48 in. diam., 15 ft. long	Domestic		The Sims Co.
1	Pump	Duplex	4½x3¾x4 in.	Circulate hot water		Deane Steam Pump Co.
1	Fire pump	Underwriters	18x10x12 in.	Fire service	150-lb. press.	Epping-Carpenter Pump Co.
2	Pumps	Duplex	10x12x12 in.	Service	Elevate river feed water to overhead tank	Epping-Carpenter Pump Co.
2	Pumps	Receiver	7½x5x6	Return condensate to heater from grain-drying system		Deane Steam Pump Co.
1	Ash conveyor	Vacuum, steam jet	8-in.	Remove ashes from boilers	8 tons per hour	Amer. Steam Conveyor Corp.
1	Coal-handling system		60 tons per hour	Elevate coal to bunker	Crusher, 2 belt conv., 1 bucket elevator	Jeffrey Mfg. Co.
2	Turbo-generators	Reaction-turbine	2,308-kv.-a.	Main units	Three-phase, 60-cycle, 600 volts, 3,600 r.p.m.	Westinghouse Elec. & Mfg. Co.
2	Condensers	Jet	3,000-hp.	Serve main units	Driven by turbine and red. gear	Westinghouse Le Blanc
1	Turbo-generator	Reaction-turbine	770-kv.-a.	Main unit	Three-phase, 60-cycle, 600 volts, 3,600 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Condenser	Jet	1,500-hp.	Serve main unit	Driven by turbine and red. gear	Westinghouse Le Blanc
1	Exciter	Turbine-driven	50-kw., 125 volt	Excitation	Reducing gear 7,200-1,200 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Exciter	Motor-driven	50-kw., 125-volt	Excitation	Three-phase, 550-volt motor, 1,120 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Exciter	Motor-driven	12½-kw., 125-volt	Excitation and charge storage battery	1,760 r.p.m.	Westinghouse Elec. & Mfg. Co.
1	Storage battery	"Exide"	60-cell	Current for remote control	25-amp., 200-hr.	Electric Storage Battery Co.

Bowser oil filter, Foster desuperheater, Westinghouse switchboard and instruments, General Electric motors in elevator; Foster, Mason and Ford pressure regulators, Schutte & Koerting stop and check valves, Chapman steam and water valves, Cranetilt steam trap, Asheroft gages, Frahm tachometers, Ellison draft gages, Chisholm & Moore 16-ton traveling crane.

depending upon the demand for exhaust steam are interchangeable for excitation purposes. Of the two storage batteries, one of 60 cells is used for emergency power-plant lighting and for operating the remote-controlled switches and rheostats. The other energizes the local telephone system having 32 instruments.

Throughout the works there are 7250 hp. in motors, unit sizes ranging from 140 hp. down. These motors are all three-phase induction machines operating at generator voltage. Lighting current is reduced in tension to 110-220 volts for three-wire distribution. Current from the generators passes through oil switches to the busses, which are located in the basement. Distribution from here to the elevator is underground. Above, on a balcony off the turbine room, are the switchboard, motor-operated rheostats and the benchboard, all of which appear in Fig. 2 before the installation was quite complete. At the right are the rheostat face plates and generator field switches with provision for electric or hand closing. Next is the switchboard containing three generator, one exciter and two lighting feeder panels. At the left is the benchboard containing the various control devices that make it possible for the switchboard operator to control the turbine speed. The oil switches, rheostats and circuit-breakers are all manipulated here. There is also control of the turbine governors so that the speed may be raised or lowered when bringing the machines into parallel. A small motor at the turbine increases or lessens the tension of the governor spring. An innovation is a signal system controlling the operation of the larger motors in the elevator. These motors may be stopped at the points of service, but their supply circuits can be closed only at the power plant. Duplicate signal lights at either end indicate the condition of the circuit. With a red light showing, the motor is shut down. When the red changes to green, the circuit is clear and the switch at the power plant may be closed.

The two boards have a full complement of the latest instruments. At the turbines are gage boards containing Frahm vibrating reed tachometers and various pressure gages. A general pressure-gage board is also mounted on the turbine-room wall.

At the present writing the plant is not in operation, although an early start is expected. C. P. Hall is plant engineer, and from him came much of the information contained in this article. The work was carried out under the direction of the engineering department of the Chicago & North Western Railway Co., W. H. Finley, chief engineer; F. C. Juffman, resident engineer.

Frequency-Changer Sets—I

By QUENTIN GRAHAM
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The construction, operation, application and characteristics of the synchronous type of frequency-changer sets are discussed.

ANY piece of apparatus that receives electrical power at one frequency and gives out power at another frequency may rightfully be called a frequency changer. Ordinarily, however, the term frequency changer is applied to a motor-generator set consisting of two synchronous machines, or a synchronous machine and an induction motor. The set made up of two synchronous machines is usually called a synchronous set and will be referred to as such in this article; the other type will be called an induction set and will be treated in a subsequent article. The discussion given will be confined chiefly to these two types, although a few of the other means of changing frequency will be mentioned later.

There are two principal applications of frequency changers. The first, which is the more common one, is the supplying of a small amount of power at one frequency when there is available a generating system of some other frequency. For example, a certain amount of 60-cycle power may be needed for lighting purposes, a short distance from a 25-cycle railway system. It will be found to be more economical in many cases to obtain power from the large system and convert it to 60 cycles by means of a frequency-changer set than to install a separate generating plant. As another example, 25-cycle power for traction work is sometimes supplied in this manner from a 60-cycle transmission system.

The second application of frequency changers is the tying together of two generating systems of different frequencies. By this means energy may be transferred from one system to the other and the generators of one station made to help out those of the other. If the loads of the two stations are such that their peaks occur at different times, such an arrangement is particularly desirable in that less generating equipment is needed in each plant. Even in cases where this interchange of power under normal conditions is not of importance it still may be highly advantageous to have the two systems coupled together. For example, if one of the plants were disabled temporarily, it would be possible for at least a part of its load to be supplied by the other plant through the frequency-changer set and thus prevent a complete interruption of power.

There are a number of installations of frequency changers in this country which are the means of coupling together large distributing systems. In Europe, where there are a great many small systems and where frequencies are not as well standardized as in this country, there are a considerable number of such installations. Experience in European countries seem to show that there are many benefits to be derived from the parallel operation of power plants by this means.

Some of the points to be considered in the application and operation of these sets and some of the differences between the synchronous and the induction sets will be given here. The synchronous set will be considered first.

A synchronous machine, either motor or generator, runs at a fixed speed that depends upon the frequency and the number of poles. Since both machines of a

frequency-changer set run at the same speed, due to their rigid mechanical coupling, it follows that the ratio between the number of poles of the generator and the number of poles of the motor must be the same as the ratio between the frequencies. For example, a set for converting 25-cycle power to 50-cycle power may consist of a 4-pole machine and an 8-pole machine, running at 750 r.p.m., or it may consist of a 6-pole and a 12-pole machine operating at 500 r.p.m. A set for changing from 25 cycles to 60 cycles may be made up of a 10-pole and a 24-pole machine. Such a set must run

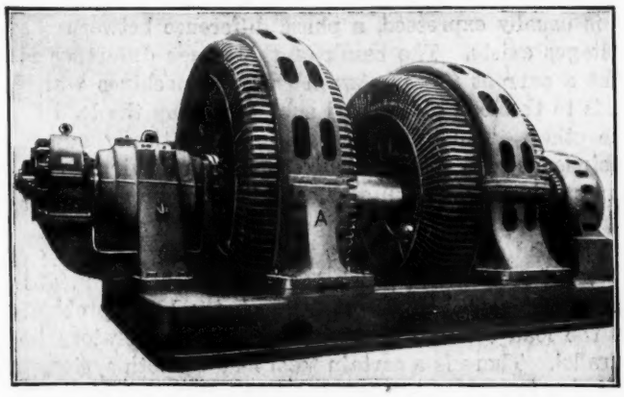


FIG. 1. SYNCHRONOUS FREQUENCY-CHANGER SET WITH DIRECT-CONNECTED STARTING MOTOR AND EXCITER

at 300 r.p.m. It will be seen that this combination of poles is the least number which can be used and give the desired frequencies, so that 300 r.p.m. is the highest speed for which a 25-cycle to 60-cycle set can be built.

Certain size machines operating at 300 r.p.m. can be built economically, but for the smaller sizes this speed is too low. That is, if a set having the same rating could be built with fewer poles and a higher speed, its weight and cost would be less. This, of course, is impossible if the correct ratio of frequencies is to be maintained.

However, it often happens that a set having a ratio of frequencies slightly different from the ratio of 25 to 60 will answer the purpose. For example, a 4-pole and a 10-pole machine give frequencies of 25 and 62.5 cycles; and since a set having this combination runs at 750 r.p.m., it can be built more economically, in many cases, than a 300 r.p.m. set of the same rating. Another combination sometimes used is 8 poles and 14 poles, which gives 25 cycles and 58.4 cycles when operating at 500 r.p.m.

Figs. 1 and 2 show the construction of typical synchronous frequency changers of recent design. The two machines that make up a set of this kind are mounted on a common bedplate and usually have a common shaft. If the set is intended to be paralleled on both ends with other synchronous sets, it is usual practice to mount one of the stators in a cradle so that it can be shifted circumferentially through a small angle relative to the other stator. Figs. 1 and 2 show sets that have such an arrangement at *A*. It will be seen that the bolt holes are slotted, to allow the stator frame to be revolved through a small angle. It is necessary to have a means of shifting one of the stators in order to obtain the proper phase relation between the voltages of the machines to be paralleled. When one set only is to be installed, this arrangement is not required.

The set may be started by a separate starting motor or may be self-starting. With practically all modern machines the self-starting method is used. A machine to be started by this method has its rotor equipped with a damping winding, as shown at *D* in Fig. 3. Either one or both machines of the set may have dampers, depending upon whether the set is always to be started from the same end or whether it is to be arranged for starting from either end. The self-starting method is widely used and consists of applying a voltage of about one-half normal to the terminals of the machine, which causes it to start as an induction motor. When it has come up to nearly full speed, the field is excited and the rotor then locks into step. The machine is then switched over to full voltage. During the starting process the damping winding acts as the secondary of an induction motor and is the means of producing the torque for starting.

If the set is to operate as a link between two systems, it is necessary to synchronize the generator end with its line before it can be paralleled with it. In order to synchronize, it is necessary to have some means of controlling the frequency of either the line or the machine that is to be connected to it. Since the speed or frequency of the generator end of the set can be controlled only by changing the frequency of the line on the motor end, it becomes necessary to have access to either one or the other of the generating stations.

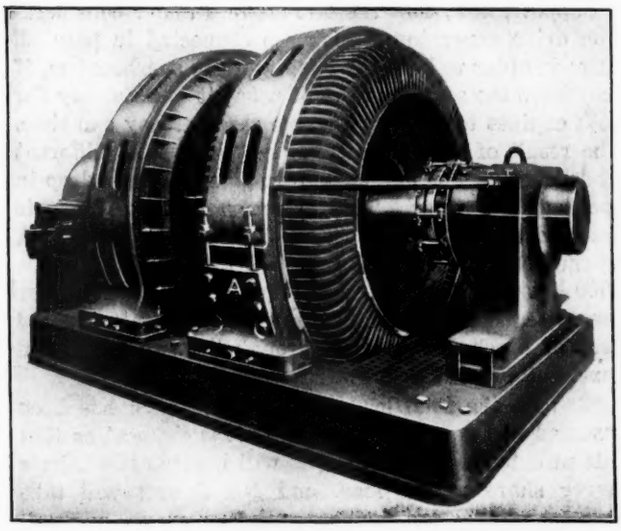


FIG. 2. SYNCHRONOUS FREQUENCY-CHANGER SET, SHOWING MEANS OF SHIFTING FRAME OF ONE MACHINE

Uusually the frequency changer is located in one of the stations, so that it is possible to adjust the frequency of that station to agree with generator end of the set.

In order to show what factors determine the direction and amount of the flow of power between two systems that are linked together by a frequency-changer set, it will be well to consider briefly the problem of load division between separate engine-driven generators in parallel. Familiarity with the action of single generators operating in parallel will help greatly in obtaining a clear understanding of the way in which two generating

systems divide the load when they are paralleled by means of a frequency-changer set. For this reason a discussion of the problem of alternator parallel operation will be given first.

The division of energy load between two separately driven generators operating in parallel depends upon the characteristics of the prime movers. For any certain governor setting, the engine or other prime mover has a definite speed regulation, or drop in speed for a given load. This may be illustrated by the curves in

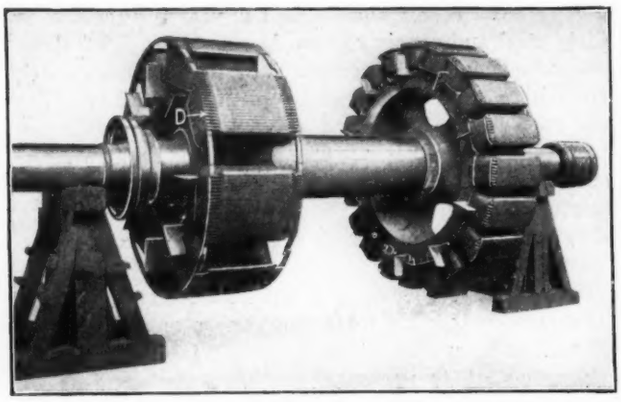


FIG. 3. ROTOR FOR SET SHOWN IN FIG. 1

Fig. 4, which show the speeds of two units for different loads. Curves such as these are determined from tests on the prime mover and are not in any way dependent upon the electrical end of the unit.

Suppose, now, that the two engines under consideration drive generators which are connected in parallel. Then in order to keep the generators in synchronism, if they have the same number of poles, it is necessary for both engines to run at the same speed at any one time. The result of this is that the two units take different loads, each taking just enough to give the same drop in speed as the other. This is shown in Fig. 4. It is assumed that a total load of 1500 kw. is to be carried, so that No. 1 unit must take 500 kw. and No. 2 unit 1000 kw. in order to keep the speeds of both machines the same. The horizontal line that represents a speed drop of 4 per cent. passes through the two regulation curves at 500 and 1000 kw. respectively.

If, with the total load of 1500 kw. which has been assumed, the governor of No. 1 unit is changed so that this unit tends to speed up, it will immediately take a larger share of the load, and No. 2 unit will take correspondingly less. The regulation curve, or load-speed curve, of No. 1 unit, with this changed governor setting, may be represented by the inclined dotted line, Fig. 4, from which can easily be seen that if both units are to run at the same speed, the division of load between them must be different from before.

In actual operation the governors are so adjusted that each unit carries load in proportion to its rating. For example, if No. 1 unit, referred to above, is half as large as No. 2, then it will carry half as much load as No. 2 if the regulation curves are as shown in the figure.

The explanation that has been given so far is based on a consideration of the mechanical end of the unit. It has been shown that in order to keep the generators at the same speed it is necessary that the prime movers be loaded a definite amount, depending upon their speed characteristics. It will be well to consider load division from the standpoint of the electrical end of the unit as well.

When two generators are operating in parallel, any tendency to speed up either of the prime movers, such as is caused by a change in the governor setting, causes one of the generator rotors to advance slightly with respect to the other. The rotors still revolve at the same speed, but one of them has moved a few degrees ahead relative to the other. This causes the voltage wave of the one to be shifted slightly ahead of the other or, as it is usually expressed, a phase difference between the voltages exists. The result of this phase difference is that a current flows between the two machines which adds to the load of one and subtracts from the load of the other. Thus the generators automatically adjust their loads so that each requires as much driving power as its prime mover can give out at the given speed and with a given adjustment of the governing device.

The load division between two generating systems of different frequencies which are tied together by means of a frequency-changer set is much the same problem as the load division between two single generators in parallel. There is a certain total load on both systems, and this is divided between the two generating stations in accordance with the tendencies of the prime movers to assume the load. The important point, of course, is to know how much power passes from one system into the other, since this amount must be handled by the frequency-changer set. Suppose there are two systems to be connected together through a 25- to 60-cycle synchronous set. Assume further that the frequencies of the low- and high-frequency systems are exactly 25 to 60 cycles respectively at a particular instant. Then if

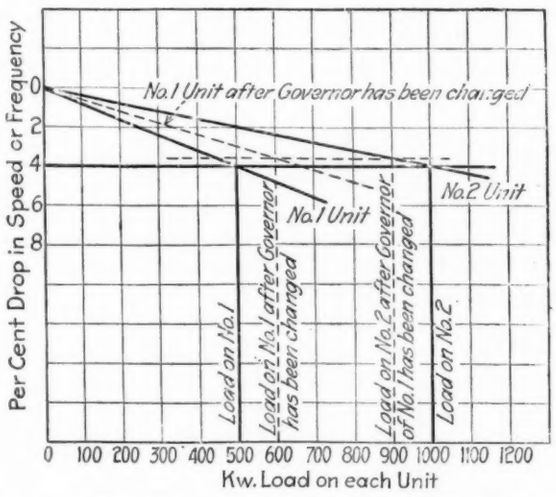

Per Cent Drop in Speed or Frequency
0
2
4
6
8
No.1 Unit after Governor has been changed
No.2 Unit
No.1 Unit
Load on No.1
Load on No.1 after Governor has been changed
Load on No.2 after Governor of No.1 has been changed
Load on No.2
0 100 200 300 400 500 600 700 800 900 1000 1100 1200
Kw. Load on each Unit

FIG. 4. SPEED-LOAD CHARACTERISTIC CURVE OF TWO ALTERNATING-CURRENT GENERATORS IN PARALLEL

the set be connected between the two, it will simply run idle and will not transfer power in either direction, since it has no tendency to speed up or slow down. However, if the prime movers of the 60-cycle station be adjusted so that they tend to slow down, the generators of that station will immediately transfer part of their load to the 60-cycle end of the frequency-changer set in accordance with the law governing the operation of generators in parallel. This, of course, loads the 25-

cycle end of the set as a motor which in turn receives power from the 25-cycle station. The 25-cycle end of the set can be made to act as a generator by the reverse process—that is, by giving the prime movers of the 60-cycle station a tendency to speed up and take more load, or by giving the 25-cycle station a tendency to shirk its load by causing the prime movers of this station to tend to slow down. Thus the direction and amount of power flow through the set may be controlled from either generating station.

When left to itself the set transfers energy automatically, depending upon the regulation, or speed-load characteristics of each station. There may be a certain 25-cycle load that, if carried entirely by the 25-cycle plant, would cause the frequency to drop 3 per cent. below that at no load. At the same time there may be enough load on the 60-cycle system to cause a 1 per cent. drop if it were all carried by the 60-cycle plant. However, if a frequency-changer set connects the two systems, it will relieve the load of one and add to the load of the other so that both have, say, a 2 per cent. drop. In other words, the power flow through the set is such as to keep the frequencies in the same ratio at all times.

It is quite possible for the set to be subjected to severe overloads under certain conditions on occount of its tendency to equalize the loads of the two stations. If the load on one system is very heavy, so that its frequency tends to drop while at the same time the other system is lightly loaded, the set would be required to transfer a considerable amount of power in order to keep the two systems in step. With the frequency on the one side tending to drop and the frequency on the other side tending to rise, the two machines of the set make an attempt to run at different speeds. Unless the set is large compared with the capacity of each station, the machines will be overloaded until one of them is pulled out of step.

The Mystery of Dr. Diesel

A series of articles appearing in the Hearst papers under the name of Axel Bjornsen purports to give the experiences of the writer in the German navy during several years of preparation for the war. In the second installment the disappearance of Dr. Diesel in the fall of the year preceding the outbreak of hostilities is accounted for. Having told of the building even at that time of a submarine of 2000 tons displacement with a surface speed of 21 knots and a cruising radius of 5000 miles, and how it lay on a mud bank within 50 minutes' run of one of the busiest ports in the British Isles and threaded its way unobserved among the trawlers of a fishing fleet, noting with the periscope every last detail of the busy craft, the marvelous undersea boat was returned to port and deliberately blown up, the author says:

Her wonderful engines were battered into nameless, shapeless scrap, and her twisted plates were made the merest junk.

"We do not risk the discovery of another of our secrets," said Steinbrink, grimly, mindful, no doubt, of the papers that had been stolen from him a few months before. "If the construction of these engines became possible to the English the work of all these years would be lost."

"But what about the man who invented them?" I asked. "Is it not true that he finds new capabilities for his oil engines every succeeding year?"

"He is wonderfully clever," said Steinbrink, with his nearest approach to enthusiasm, "but we have paid him well, and we watch him better. I do not think anything is likely to leak out through our dear Dr. Diesel."

. . . . . .

My reference to Dr. Diesel, the clever inventor of the remarkable engines which make the U-boat the terror of the seas, had more behind it than I was aware of at the time.

The engines of his invention, which consume heavy oil of any kind and bid fair, when the war is over, to revolutionize shipbuilding, were in use on all sorts of merchant vessels even at the time when I had my conversation with Steinbrink. But the engines in use on the super-submarine were an astonishing advance upon the Diesel engine known to commercial shipping.

In October, 1913, Dr. Diesel left Munich with the intention of crossing to England. He announced that his journey was taken in connection with the British company which was to handle his inventions; and it is true that a meeting of that concern was to be held upon his arrival in England.

On Oct. 1 he reached Antwerp, where he embarked on board the steamer "Dresden," bound for Harwich. When the "Dresden" reached the British port Dr. Diesel was not to be found. He had disappeared during the night, and it was given out that his affairs were in such disorder that he had committed suicide, despairing of ever getting them straight again.

I encountered Commander Steinbrink not many days after the disappearance of Dr. Diesel was made public and ventured to comment upon the mystery which surrounded his end. He smiled his grim Prussian smile and looked at me from under lowered eyebrows.

"You were right, Axel," he said, shortly, "when you suggested that the secret of our submarine engines might not be safe with its inventor; and the German Government was right in keeping a close watch upon the traitor Diesel. He met the end he deserved; he was executed when on his way to sell to the damned British an improvement on the engines we have tested."

I stared at him in open dismay.

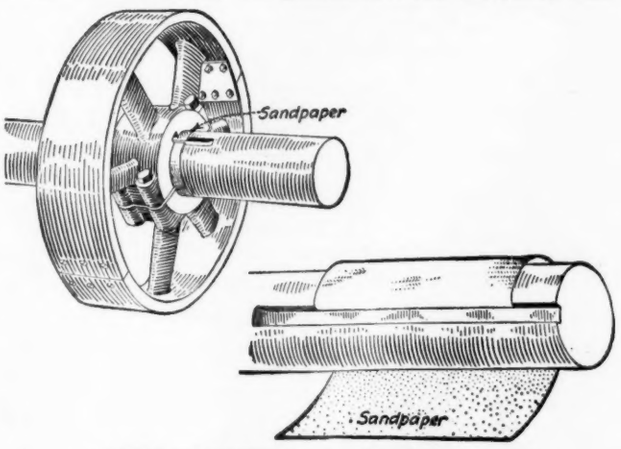
"And he was ——," I made the motion with my hands of pushing a man overboard from a steamer.

Steinbrink nodded complacently. "It is what happens to people who have the will to betray the secrets of our Fatherland," he said, with a keen glance at me.

Sandpaper Replaces Pulley Key

BY H. S. CARPENTER

The key on the drive pulley of a crusher sheared off and an immediate repair was necessary. As a temporary expedient, the pulley was unbolted, spread, and a layer of sandpaper was placed between the pulley and



LAYER OF SANDPAPER TAKES PLACE OF STEEL PULLEY KEY

the shaft. The holding-bolts of the pulley were then drawn up tight and the crusher put into operation.

No trouble developed, the pulley driving the crusher without slipping and giving perfect satisfaction.

Hot-Water Heating Under Forced Circulation—II

By CHARLES D. ALLAN*
Consulting Engineer for the Mechanical Equipment of Buildings, Chicago

Development of friction-head formulas from which logarithmic charts are plotted giving directly the relation between friction head, velocity, B.t.u. per hour and size of pipe. The charts are based on 20- and 30-deg. water-temperature drops and range from 10,000 to 100,000,000 B.t.u.

SPACE will not permit a discussion of the various formulas for the friction of water in iron pipes, all of which are more or less empirical in character, of the same general form, subject to error by reason of the condition of interior pipe surface and equally suitable to the same form of analysis and arrangement for use as the one that will be presented.

In the "Mechanics of Heating and Ventilating," by Konrad Meier, there is a most excellent discussion of these formulas explaining the probable greater reliability of those with fractional exponents, to which the reader is referred.

The equation here used is almost identical in form and results to that adopted in the treatise named. It is in fact the same except that the exponent of V has been changed from 1.86 to 1.875, so that when multiplied by 2 and added to the exponent of d, the sum will be exactly 5, thereby making it easier to handle, as will be seen. In order that the results may not be materially altered by this change, the coefficient has been reduced from 0.0004 to 0.00038. The equation is

$$H_F = \frac{0.00038 L V^{1.875}}{d^{1.25}} \quad (1)$$

in which

H_F = Friction head in feet;
0.00038 = Empirical constant;
L = Length of pipe in feet;
V = Velocity of flow in feet per second;
d = Inside diameter of pipe in feet.

If H_F is the friction-head loss in a unit length of 100 ft. and d is expressed in inches, the formula becomes

$$H_F = \frac{0.038 \times 12^{1.25} V^{1.875}}{d^{1.25}} = \frac{0.8475 V^{1.875}}{d^{1.25}} \quad (2)$$

In formula (2) H_F is now the friction head loss in feet per 100-ft. length of pipe, and in the following subject matter it will be so considered. This gives a mathematical relationship between three variable quantities: H_F, the friction head loss in feet head per 100 ft. of pipe; d, the diameter of the pipe in inches; and V, the velocity of flow in feet per second. As this formula is to be applied to a system of heat distribution using water as the heat-carrying medium, its form must be changed to designate heat-carrying capacity W, in B.t.u. per hour, for different drops of temperature T, in degrees F., of the circulating water. The heat-carrying capacity of a pipe in which water is flowing can be expressed by the equation,

$$W = \frac{(0.7854 \times 60 \times 60 \times 60.32) T V d^2}{144} = 1184.5 T V d^2 \quad (3)$$

in which

W = B.t.u. per hour delivered;
60 = Seconds in one minute;
60 = Minutes in one hour;
60.32 = Weight of 1 cu.ft. of water at 190 deg.;
T = Drop in temperature of circulating water in degrees F.;
V = Velocity of flow in feet per second;
d = Inside diameter of pipe in inches;
144 = Square inches in 1 sq.ft.

It is almost uniform practice to design a forced hot-water heating system for a temperature drop of 20 deg. in making the circuit from and back to the pump. If T is made equal to 20, equation (3) becomes

$$W = 23690 V d^2 \quad (4)$$

By successively eliminating d and V from equations (2) and (4), the algebraic and logarithmic details of which are not essential to the subject matter, the following equations are obtained:

$$H_F = \frac{0.000000005328 W^{1.875}}{d^5} \quad (5)$$

$$H_F = \frac{460 V^{2.5}}{W^{0.625}} \quad (6)$$

In these formulas are shown the mathematical relationships between H_F, W and d, and between H_F, W and V when the drop in temperature of the circulating water is 20 deg. F.

These formulas are cumbersome and inconvenient, so that a way must be found for their solution and arrangement for practical use by charting or tabulation. The former method is better suited to illustrate the theory of flow, and the charts can then be used to construct a working table, figured in terms of square feet of radiation, that will fully cover the ground for all practical purposes.

It would be tedious and difficult to locate all the points necessary to plot the curves representing the individual values of V and d on ordinary coördinate paper on which vertical and horizontal distances to scale represented H_F and W. A much simpler method is to reduce these equations to their logarithmic form, in which they can be laid out in straight lines on logarithmic paper and solutions read at a glance.

When changed to logarithmic form, equation (5) becomes

$$Log\ H_F = 1.875\ log\ W + log\ 0.000000005328 - 5\ log\ d \quad (7)$$

and equation (6) becomes

$$Log\ H_F = -0.625\ log\ W + log\ 460 + 2.5\ log\ V \quad (8)$$

In each of these equations the last two terms will merge into one numerical constant when individual numerical values are given to V and d, and each will then be of the form of the equation of a straight line referred to rectangular coördinates; namely, $y = mx + b$, in which m is the natural tangent of the angle

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between the line and the horizontal axis, and b is the intercept on the vertical axis.

Hence these two equations in their logarithmic forms can be plotted on logarithmic paper, in which both vertical and horizontal lines are ruled in distances apart corresponding to the graduations on an ordinary slide rule, and represent the logarithms of H_F or W to scale and not their actual values.

On such a chart, parallel straight lines inclined to the horizontal at an angle whose natural tangent is 1.875 (approximately 62 deg.) will represent the various pipe diameters corresponding to the commercial sizes of wrought-iron and steel pipe, and another set of parallel straight lines inclined to the horizontal at an angle whose natural tangent is 0.625 (approximately 32 deg.) will represent velocities in feet per second. The lines of diameter will slope to the right, as 1.875, the coefficient of W (in 7), is positive, while the lines of velocity will slope to the left, as 0.625, the coefficient of W (in 8), is negative.

Charts 1, 2, 3 and 4, prepared by the foregoing method, are in reality one continuous chart divided into four sections for convenience in publishing, the necessary points for the location of the lines of diameters and velocities having been read from the Allan friction-head slide rule, which is graduated from the same equations. Vertical reading at the left side represents H_F per 100 ft. of pipe from 0.1 to 10 ft. inclusive. Horizontal reading at the top or bottom represents B.t.u. per hour. The B.t.u. reading at the top of the chart if divided by 10,000, or that at the bottom divided by 15,000, will give the gallons per minute flowing at the

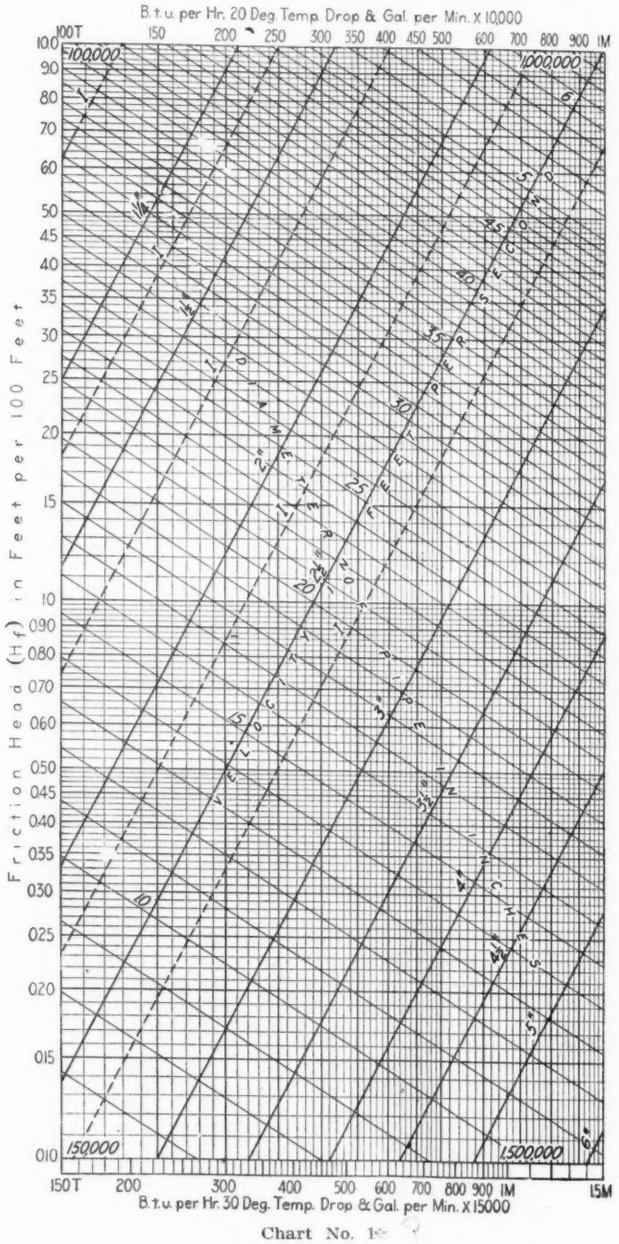

B.t.u. per Hr. 20 Deg. Temp. Drop & Gal. per Min. X 10,000
Friction Head (Hf) in Feet per 100 Feet
B.t.u. per Hr. 30 Deg. Temp. Drop & Gal. per Min. X 15000

Chart No. 1

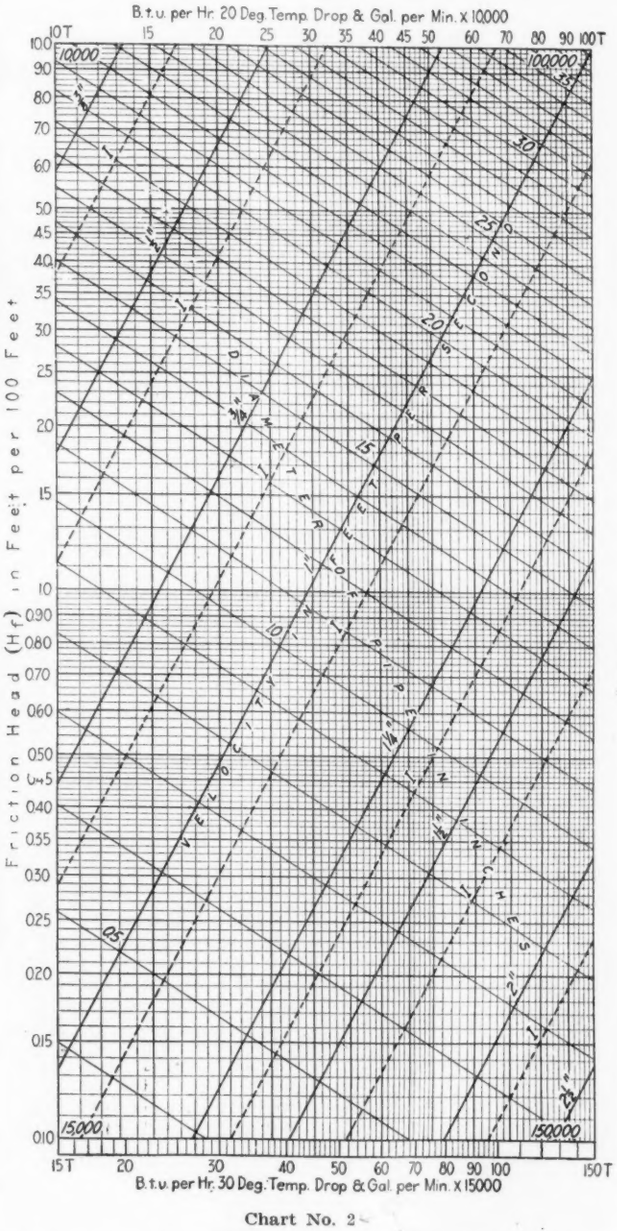

B.t.u. per Hr. 20 Deg. Temp. Drop & Gal. per Min. X 10,000
Friction Head (Hf) in Feet per 100 Feet
B.t.u. per Hr. 30 Deg. Temp. Drop & Gal. per Min. X 15000

Chart No. 2

CHARTS SHOWING HEAT TRANSMITTED PER HOUR BY WATER AND FRICTION HEAD WITH GIVEN VELOCITY IN PIPES OF DIFFERENT SIZES. DIAMETERS REPRESENT COMMERCIAL SIZES

Chart 1—Range on 20-deg. temperature drop 10,000 to 100,000 B.t.u. per hr.; 30-deg. drop, 15,000 to 150,000 B.t.u. Chart 2—Range on 20-deg. temperature drop, 100,000 to 1,000,000 B.t.u. per hr.; on 30-deg. drop, 150,000 to 1,500,000 B.t.u.

velocity and in the pipe size given, because (considering the top scale) lb. per hour $= \frac{\text{B.t.u.}}{20}$ (per hour) and lb. per min. $= \frac{\text{B.t.u. (per hour)}}{20 \times 60}$ so that gal. per min. $= \frac{\text{B.t.u. (per hour)}}{20 \times 60 \times 8\frac{1}{3}}$ or $\frac{\text{B.t.u. (per hour)}}{10{,}000}$. The same applies to the reading at the bottom of the chart except that 30 is substituted for 20, making the final divisor 15,000, the letters *T* and *M* indicating thousands and millions respectively. The four charts cover from 10,000 B.t.u. per hour (about 50 sq.ft. of radiation) to 100,000,000 B.t.u. per hour (about 500,000 sq.ft. of radiation) on a basis of a 20-deg. drop in the temperature of the circulating water. At 30 deg. drop the effect is, of course, proportionally greater.

Below 3 in. diameter there are intermediate pipe sizes marked *I*, indicating imaginary sizes of pipe which would give the same frictional effect in a unit length as two consecutive half-unit lengths of the regular sizes between which each is located. The reciprocals of the fifth powers of the diameters of these imaginary sizes are means between the reciprocals of the fifth powers of the diameter of the two sizes between which each is located.

At the bottom of each chart is a scale showing *W* with a 30-deg. temperature drop, for if the conditions of flow are coincident, a 30-deg. drop would give 1.5 times the heat loss of the 20-deg. drop, the two scales being set in the position of the scales on an ordinary slide rule when multiplying 1 by 1.5. Where individual diameter and velocity lines cross, diameter and velocity

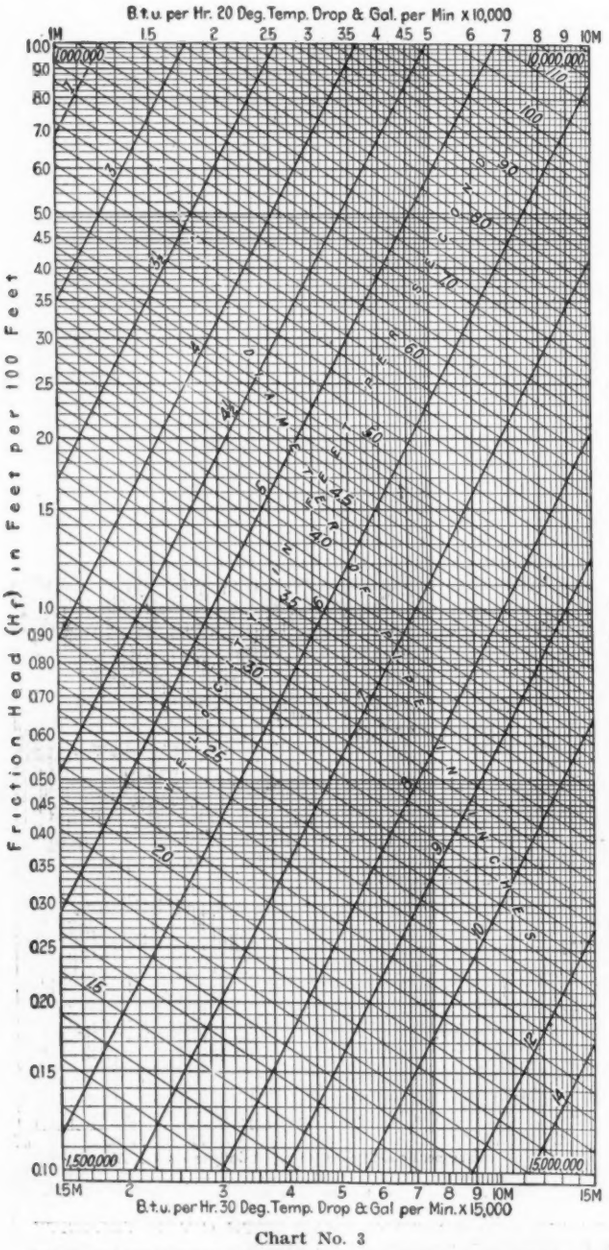

B.t.u. per Hr. 20 Deg. Temp. Drop & Gal. per Min x 10,000
Friction Head (Hf) in Feet per 100 Feet
B.t.u. per Hr. 30 Deg. Temp. Drop & Gal. per Min. x 15,000

Chart No. 3

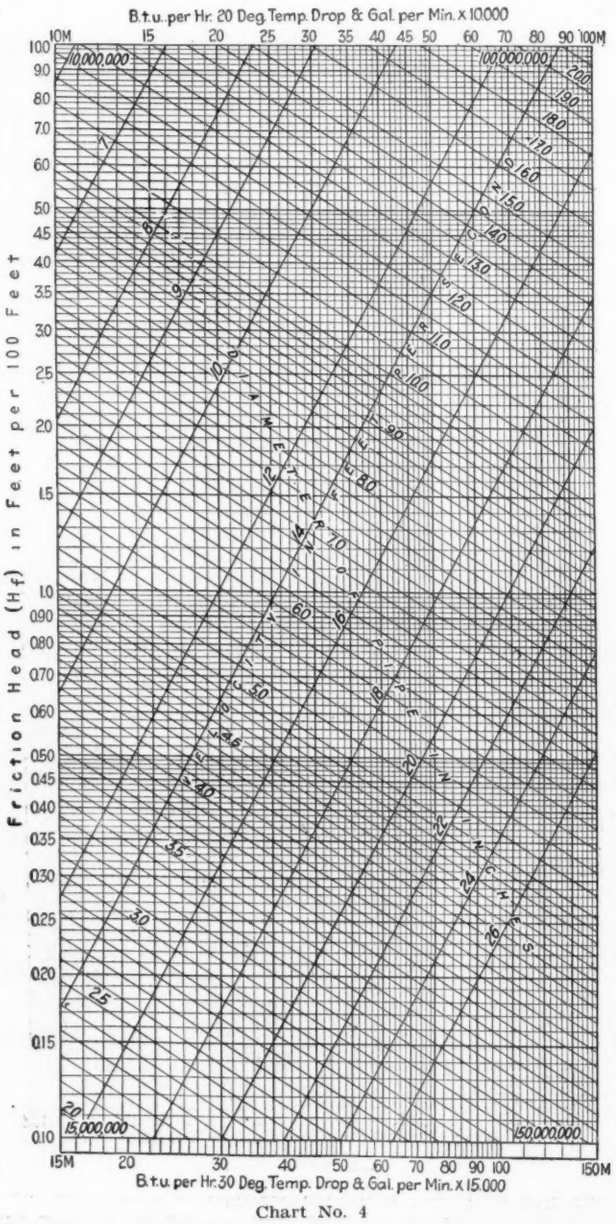

B.t.u. per Hr. 20 Deg. Temp. Drop & Gal. per Min. x 10,000
Friction Head (Hf) in Feet per 100 Feet
B.t.u. per Hr. 30 Deg. Temp. Drop & Gal. per Min. x 15,000

Chart No. 4

CHARTS SHOWING HEAT TRANSMITTED PER HOUR BY WATER AND FRICTION HEAD WITH GIVEN VELOCITY IN PIPES OF DIFFERENT SIZES. DIAMETERS REPRESENT COMMERCIAL SIZES

Chart 3—Range on 20-deg. temperature drop, 1,000,000 to 10,000,000 B.t.u. per hr.; on 30-deg. drop, 1,500,000 to 15,000,000 B.t.u. Chart 4—Range on 20-deg. temperature drop, 10,000,000 to 100,000,000 B.t.u. per hr.; on 30-deg. drop, 15,000,000 to 150,000,000 B.t.u.

are coincident with H_F and W, as indicated by horizontal and vertical lines from the point of crossing to the H_F and W scales at the side and top.

From the point of intersection of a given pipe size and velocity read horizontally to the left for friction head, H_F, and vertically up for W, the B.t.u. given up per hour by the water with a 20-deg. drop in temperature—this reading divided by 10,000 gives the gallons per minute flowing or reading vertically down from the same point of intersection the B.t.u. given up per hour by the water with a drop of 30 deg. in temperature; this reading in turn if divided by 15,000 gives the gallons per minute flowing.

These charts give the basic data from which tables reduced to terms of square feet of radiation may be derived to suit the average temperature of the circulating water and the resulting heat transmission per square foot which the engineer may consider desirable. Such a table can be figured from the charts in a few moments to suit the work in hand.

Tom Hunter, Hoisting Engineer

By WARREN O. ROGERS

We visit the Red Jacket mines and find a different type of hoist handling ore from a depth of 8000 ft. We also see two four-cylinder engines at the Tamarack mines. These are the largest hoists in the world, but will soon be surpassed in size by one now being installed. We also run across a winding drum 31 ft. diameter.

YE GODS! More snow!" exclaimed Hunter the next morning as he made a duck to turn steam into the radiator. "But it looks too wet to amount to much." It didn't, and by the time we were ready to start out it had nearly ceased falling.

"Instead of taking in the stamp mill as we proposed yesterday, I am going to show you a different kind of hoisting engine today," said Hunter, as we started in a different direction from usual. Arriving at the edge of the town, I saw in the distance the famous Red Jacket mine (Fig. 2) and beyond it the smoke from the Tamarack.

"When you get inside of that building, you will see an engine that operates a somewhat different type of hoist from any you have yet seen. In fact, there are two of them, but one is not used much at present."

Upon entering the hoist room, we found two massive hoists, one of which is shown in Fig. 1.

"For years the method of hoisting at both the old Calumet and Hecla mines was by means of constant

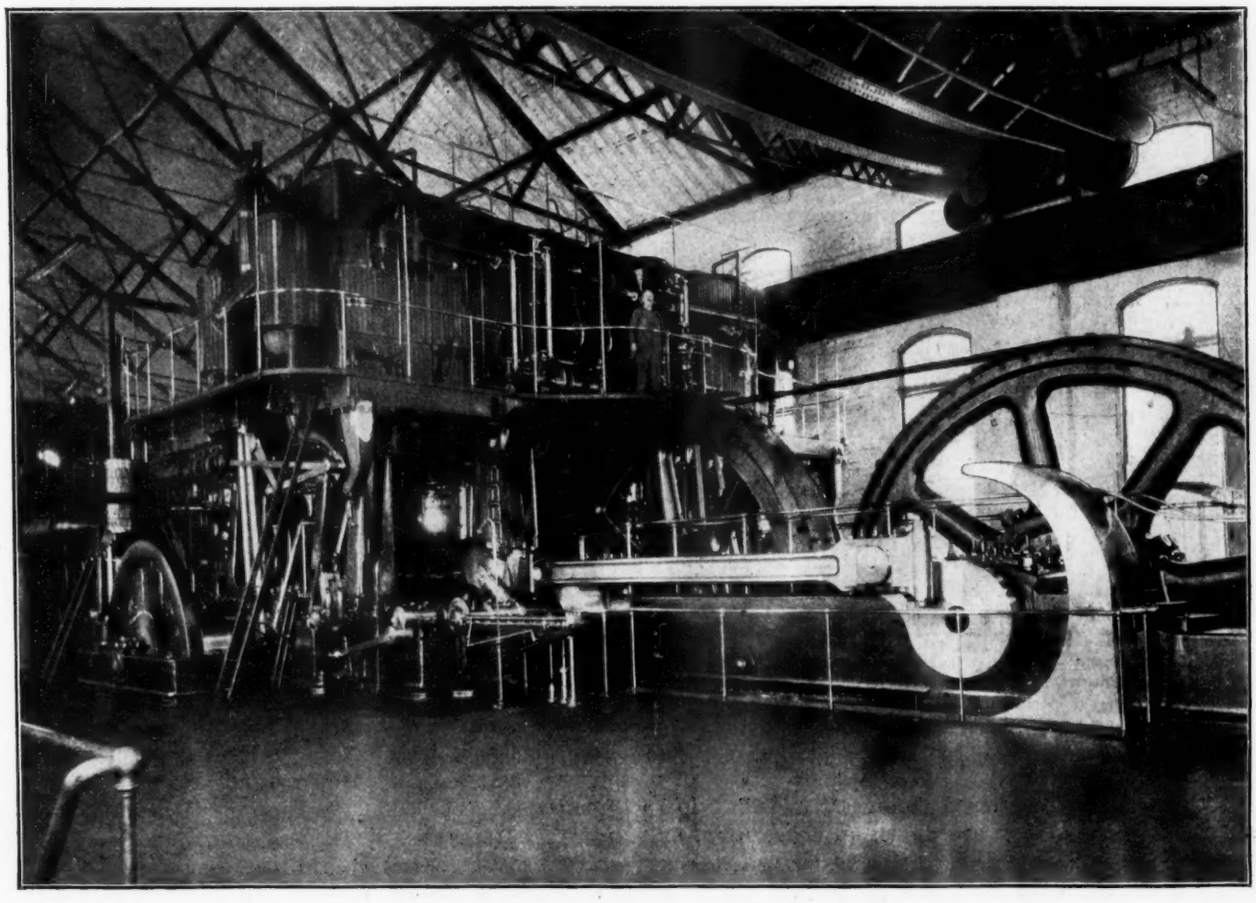


FIG. 1. ONE OF THE MASSIVE TRIPLE-EXPANSION ENGINES AT RED JACKET

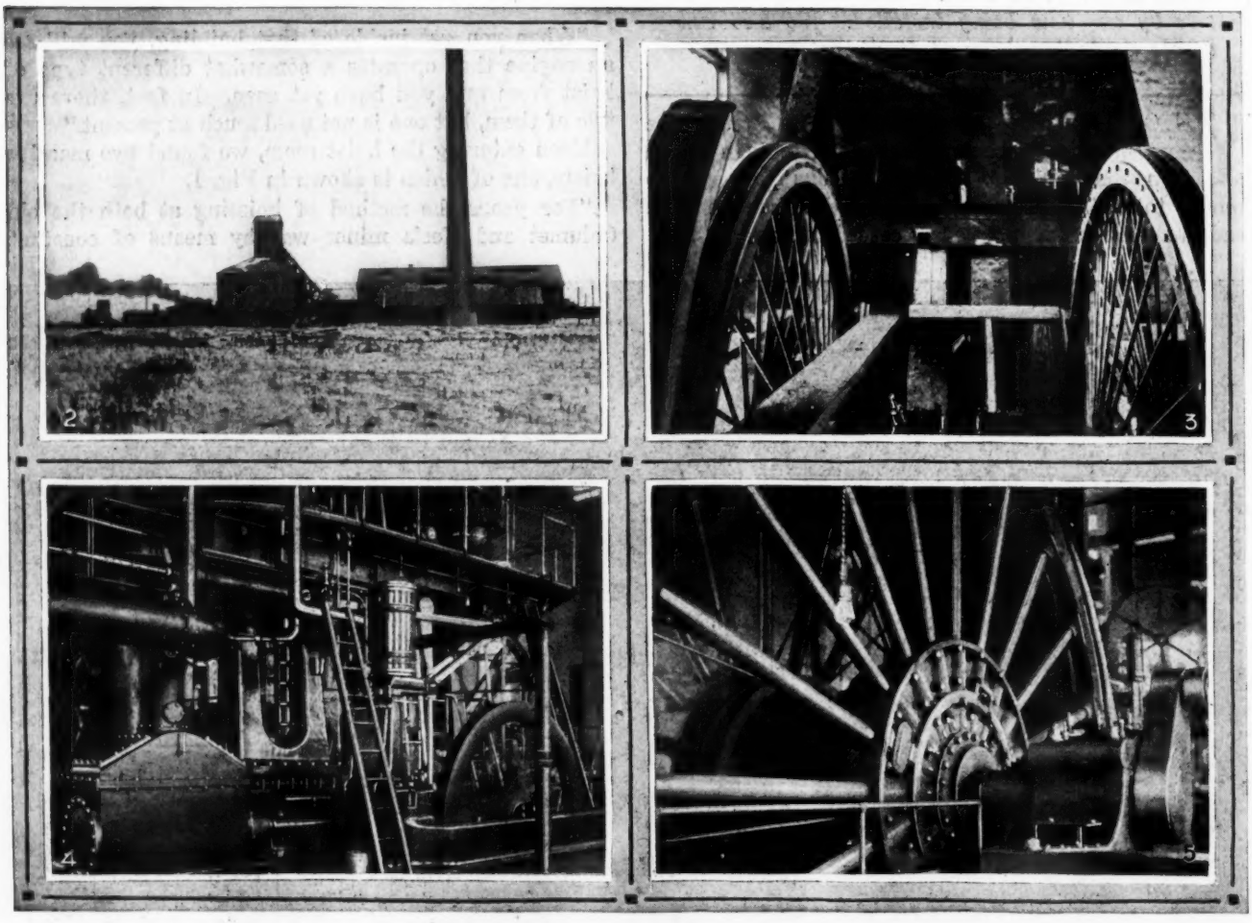
running engines which also drove air compressors. The hoisting drum was mounted free on a shaft and was made to revolve by means of a clutch. There was also a brake to prevent the drum from moving and for holding it fast whether the engine was running or not.

"Both the clutch and brake were operated by means of hydraulic pressure and the levers controlling them were interlocked so that the clutch and brake could not be thrown on simultaneously. The clutch cylinder was secured to an arm of the flywheel and the water was introduced through the shaft which was bored for the purpose.

"When S. B. Whiting went with the Calumet & Hecla Company the Whiting system of hoisting was introduced. It was first used at the Red Jacket shaft where we are now and consisted of two cages, one descending as the other ascended, with a rope from the bottom of one to the bottom of the other thus effecting a balance. The introduction of reversing engines brought new problems in engine design. The first engines were those you see here, the Minong & Siscowit." Fig. 7 shows Morris design with a valve gear similar to those I have told you about. Each has two three-crank rockers. As you see, the high and intermediate cylinders are connected to one end of one rocker-arm and the low-pressure cylinders to the other rocker. By this arrangement one rocker-arm receives power from four cylinders and the other one from the two low-pressure cylinders. The third crankpin of each rocker is connected to a crank on the first sheave wheel, and from this a side rod connects with a crank on the second sheave wheel. Each sheave wheel is 19 ft. in diameter, and they are placed in tandem."

"I fail to see how that operates the apparatus, for it seems to work altogether different from any of the others."

"It is different," answered Hunter. "You see, this is one of the few vertical shafts in the copper region. It is over 8000 ft. deep, and two skips in balance are used. The arrangement of the cable is about like this," and Hunter sketched Fig. 6. "One end of the cable is secured to the top of the skip *A* and extends over the



FIGS. 2 TO 5. VIEWS AT THE RED JACKET AND TAMARACK MINES
Fig. 2—The famous Red Jacket mine. Fig. 3—Steel work and sheave wheels at Red Jacket. Fig. 4—Independent jet condenser for the engine. Fig. 5—A 31-ft. diameter drum at Tamarack No. 2

an elevation of one of the engines and the Whiting drums.

"These engines," continued Hunter, "are both triple expansion. Really, they are duplex or twin units, as there are two cylinders of each size, which are 20½-in. high, 31¾ intermediate and 50-in. low pressure, with a common stroke of 72 in. They are of the Leavitt-headgear sheave wheel and down over idler sheaves to the two 19-ft. sheaves, being wound around the latter three times." See Fig. 3. "The rope is then extended through a tailrace 312 ft. long and, passing over a carriage sheave, is returned to the headgear sheave and is then secured to the skip *B*. To the bottom of each skip a balancing tail rope is secured and is kept tight

by a weighted sheave *C*. You can see that these skips operate about the same as a double-skip hoist using a single drum; one skip is at the top when the other is at the bottom of the shaft. You have doubtless noticed that the engine exhausts to an independent jet condenser with the steam cylinders vertical and the air cylinder in a horizontal position." See Fig. 4. "The condenser is at one end of the engine frame and runs continuously." From the rock-hoisting engine room we went to the man-hoisting engine, which was a duplex tandem-compound Corliss having two 16- and two 32-in. cylinders with a 48-in. stroke. The drum of this hoist was flat, 25 ft. in diameter, and carried a $1\frac{3}{8}$-in. rope. No rock was hoisted by this unit. As we were near the Tamarack mine, Hunter suggested that we go over and look around. Upon entering the engine room, I was again astonished at the size of the hoisting units. "You are now looking at the two largest operating hoists in the world," said Hunter. (See Fig. 8). "I won't dispute you for a moment," I replied. "These are the two Nordberg celebrated double-inclined four-cylinder hoists. Each of the cylinders is 34 x 60 in., and they are arranged in pairs at right angles. The drum is of the conical type, 25 ft. diameter at the center and 16 ft. at the end. The hoist has a capacity of 6000 ft. of $1\frac{1}{2}$-in. rope; the rock skip weighs 8200 lb. and has a capacity of 12,000 lb. of rock, and the maximum static rope pull is 42,000 lb. These hoists operate at a rope speed of 6000 ft. per minute in everyday service.

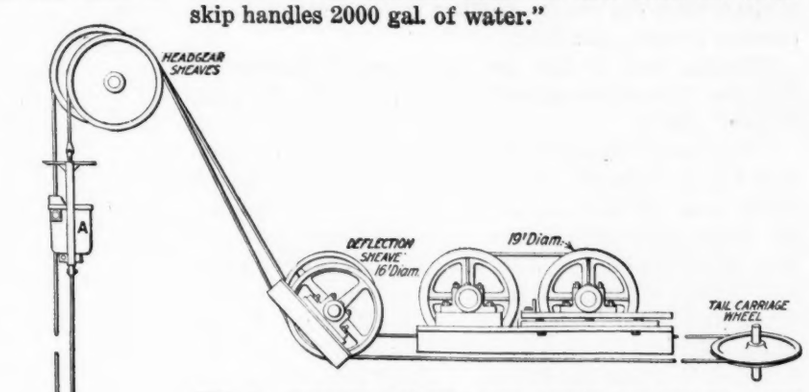


FIG. 6. SHEAVE WHEEL AND CABLE ON 8000-FT. DEEP VERTICAL SHAFT

"This shaft, No. 5, is over a mile deep and has four compartments. Ore is hoisted from two compartments and water from the mine from the other two. One of the engines is used exclusively for rock hoisting and the other for water and men. At each hoist the water skip handles 2000 gal. of water."

"As these engines have simple cylinder arrangements, they must operate noncondensing. Isn't that something unusual for such a large unit?" I asked.

"Yes, that is to be wondered at. I have often speculated as to why compounding was not used. Over on the other side, in Europe, there are a great many twin, tandem or duplex compound engines used for hoisting work, if the hoist is of any size. Our engineers sometimes assume that a condensing hoist is not a good proposition except for various deep mines, because the saving due to a vacuum is obtained only when the hoist is running at normal speed, and that during the period of starting the excess steam consumption overbalances the saving during the rest of the hoisting period."

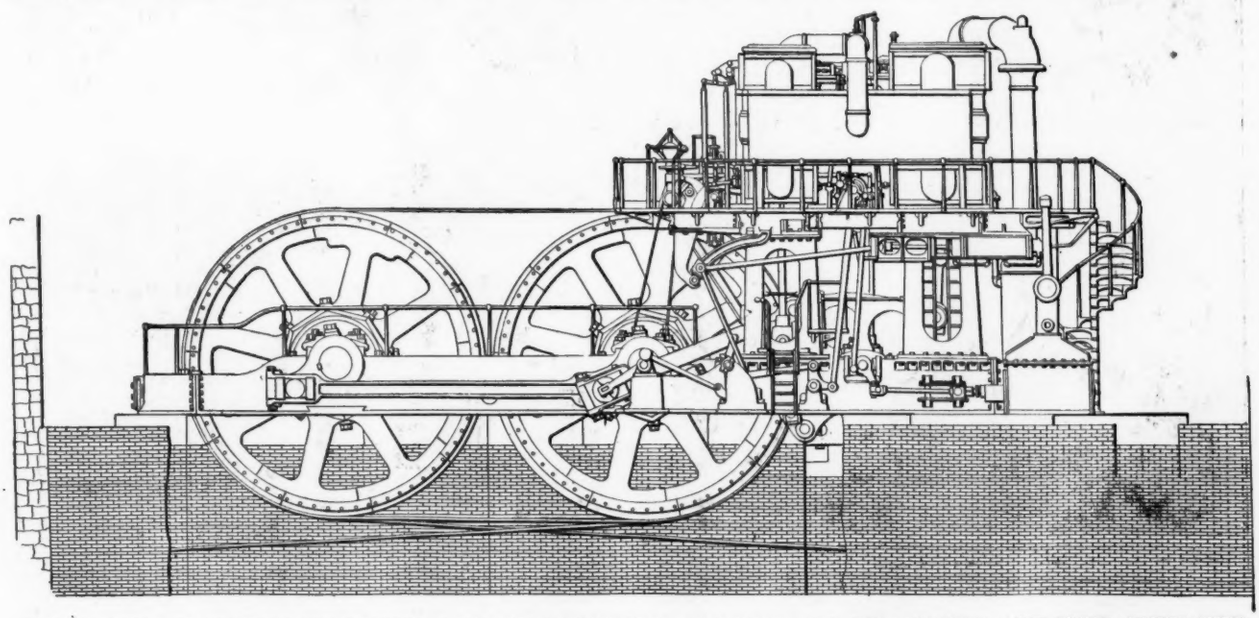


FIG. 7. SIDE ELEVATION OF MINONG & SISCOWIT HOISTING ENGINES. THESE ENGINES ARE USED WITH THE WHITING SYSTEM OF HOISTING AT THE RED JACKET MINE

"Well, I should think that would be true. Where does the kick come in?"

"It might be true if the condensers were too small to handle the large volume of steam at the start of the trip, but if the condenser were of the proper size and design, the saving would be about as great during the starting period as when running at full speed. That

should apply to these hoists as well, even though the shaft is a deep one. The average steam consumption is greater for shallow shafts than for deep ones, in comparison with the depth, whether the engine runs condensing or noncondensing."

"Getting back to the size of engines, I understand that the Homestake mines have a mighty big hoisting engine," said I.

"They have," answered Hunter. "One is a cross-compound hoist with 28 and 52 x 42-in. inclined cylinders, which meet at the apex of the triangle, thus bringing the high- and low-pressure cylinders close together. This hoist is equipped with two reels, plate clutch and post brakes, all operated by thrust cylinders. I believe the shaft is 3000 ft. deep and that the rope has a total pull of 41,900 lb." See Fig. 9. "This hoist will, I understand, be surpassed in size by a new engine that will not only be the largest compound unit yet constructed, but will be the largest hoist in the world as regards capacity. It will have two high- and two low-pressure cylinders, 32 and 60 in., with a common stroke of 66 in. The cylinders are arranged on an angle of 45 deg., similar to the Tamarack engine. The drum will be of the conical type, 16 ft. diameter at the small end and 30 ft. at the center, or 5 ft. greater diameter than the drums of these Tamarack engines. The hoist is designed to handle 10 tons of ore from an ultimate depth of 10,000 ft. in a shaft having an incline of between 35 and 45 deg. Talking of size, over at Tamarack No. 2 you will find an Allis twin hoist that has a drum 31 ft. in diameter. The shaft is 4325 ft. deep and is worked with a double skip."

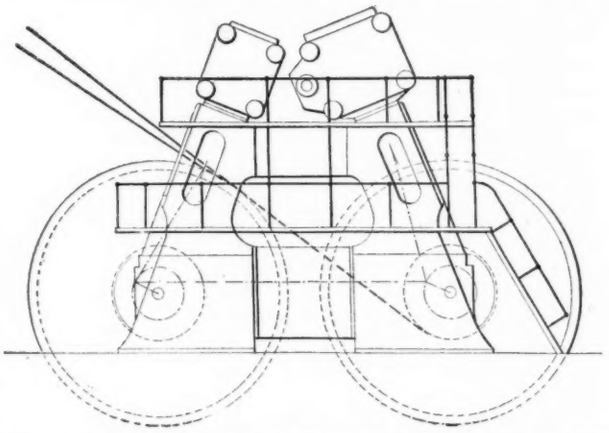


FIG. 9. CYLINDER AND REEL ARRANGEMENT OF THE HOMESTAKE COMPOUND ENGINE

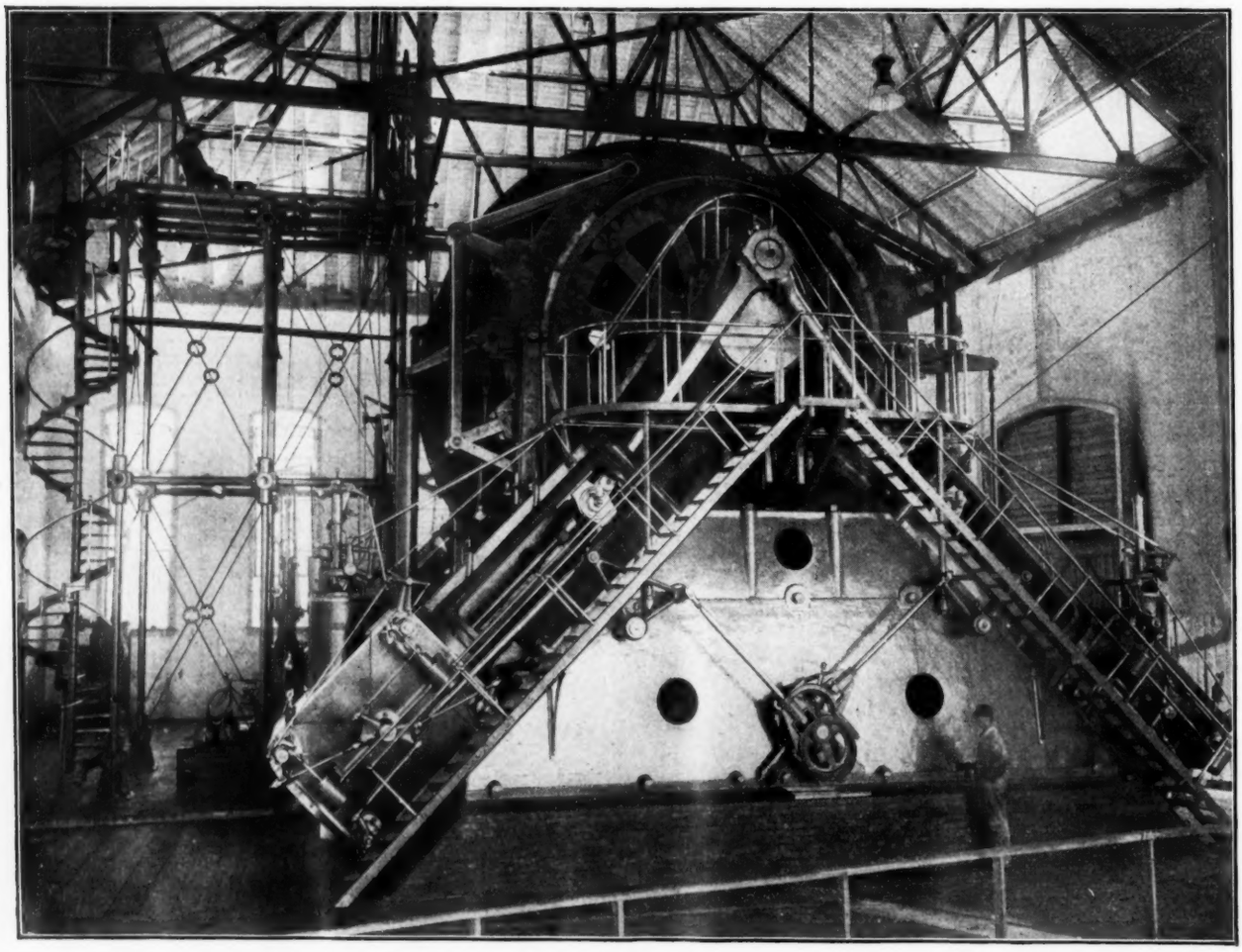


FIG. 8. ONE OF THE TWO LARGEST HOISTING ENGINES IN THE WORLD AT NO. 5 TAMARACK. THE CYLINDERS ARE 34 x 60 IN. AND THE CONICAL DRUM IS 25 FT. DIAMETER AT THE CENTER AND 16 FT. AT THE ENDS

We later saw this drum. Fig. 5 gives an idea of its size. As the afternoon was well advanced, we gave up sight-seeing for the day and began our tramp to the hotel through the snow that had turned into slush.

United States Shipping Board—Free Engineering Schools

[In view of the many inquiries reaching us relative to qualifications for entrance to the United States Shipping Board Free Engineering Schools, and because of the numerous complaints made to us by stationary engineers who are technically qualified for admission to the schools, but are rejected because they lack sea experience, although the Board's information circulars say nothing of sea experience being necessary for a stationary-engineer applicant, we are pleased to present to the readers of "Power" the following communication from Prof. F. L. Pryor, New York School at Stevens Institute of Technology, Hoboken, N. J.—Editor.]

THE school is open only to citizens of the United States. In certain cases, where an engineer already holds a license from an allied country, he is eligible to attend the school. The candidate must be at least 19 years of age and have had experience recognized by the United States Steamboat Inspection Service as being according to their regulations.

The school has for its object the training of men so that with their practical experience they will make satisfactory operating engineers for seagoing vessels. Engineers with low-grade licenses can attend the school and study with the object of securing a higher-grade license. Candidates having the necessary experience are entitled to attend license examinations without going to the school, but those men having had no opportunity to previously obtain technical training are the ones most beneficially affected.

The United States Steamboat Inspection Service Regulations, which are also used to govern the admission to the school, are as follows:

Eligible as Third-Class Engineer: An applicant for license as third assistant engineer of ocean steam vessels shall be eligible for examination after he has furnished satisfactory documentary evidence to the local inspectors that he has had the following experience:

First—Three years' service as fireman on ocean or coastwise steam vessels; or

Second—Two years' service as oiler, or water tender, or combined service of two years in these positions, on ocean or coastwise steam vessels; or

Third—Six months' service as chief or assistant engineer on lake, bay or sound steam vessels; or

Fourth—One year's service as chief or assistant engineer of river steam vessels; or

Fifth—A graduate from the engineering class of a nautical schoolship; or

Sixth—A journeyman machinist who has been engaged in the construction or repair of marine steam engines.

In cases where the experience of an applicant for license as third assistant engineer of ocean steam vessels does not meet the specific requirements of this section, other service which the local inspectors consider a fair and reasonable equivalent may be accepted by them in lieu of the service herein specified.

Eligible as Second-Class Engineer: An applicant for license as second assistant engineer of ocean steam vessels shall be eligible for examination after he has furnished satisfactory documentary evidence to the local inspectors that he has had the following experience:

First—One year's service as third assistant engineer of ocean or coastwise steam vessels; or

Second—Six months' service as chief engineer, first assistant engineer or second assistant engineer of lake, bay or sound steam vessels; or

Third—One year's service as third assistant engineer of lake, bay or sound steam vessels; or

Fourth—Three years' service as oiler, or water tender, or combined service of three years in these positions, on ocean or coastwise steam vessels; or

Fifth—A graduate from the engineering class of a nautical schoolship together with three months' service in the engine department of ocean or coastwise steam vessels; or

Sixth—A graduate in mechanical engineering from a duly recognized school of technology, together with three months' service in the engine department of ocean or coastwise steam vessels; or

Seventh—Three years' service as an apprentice to the machinist trade and engaged in the construction or repair of marine, stationary or locomotive engines, together with six months' service in the engine department of ocean or coastwise steam vessels; or

Eighth—One year's service as a locomotive or stationary engineer, together with six months' service in the engine department of ocean or coastwise steam vessels; or

Ninth—**One year's service as stationary engineer in full charge of a plant of not less than 1000 horsepower.**

In cases where the experience of an applicant for license as second assistant engineer of ocean steam vessels does not meet the specific requirements of this section, other service which the local inspectors consider a fair and reasonable equivalent may be accepted by them in lieu of the service herein specified.

Eligible as First-Class Engineer: An applicant for license as first assistant engineer of ocean steam vessels shall be eligible for examination after he has furnished satisfactory documentary evidence to the local inspectors that he has had the following experience:

First—One year's service as second assistant engineer of ocean or coastwise steam vessels; or

Second—One year's service as chief or first assistant engineer of lake, bay or sound steam vessels; or

Third—Two years' service as third assistant engineer of ocean or coastwise steam vessels; or

Fourth—Three years' service as an apprentice to the machinist trade and engaged in the construction or repair of marine, stationary or locomotive engines, together with one year's service in the engine department of ocean or coastwise steam vessels; or

Fifth—A graduate from the engineering class of a nautical schoolship, together with six months' service in the engine department of ocean or coastwise steam vessels; or

Sixth—A graduate in mechanical engineering from a duly recognized school of technology, together with six months' service in the engine department of ocean or coastwise steam vessels; or

Seventh—Two years' service as locomotive or stationary engineer, together with one year's service in the engine department of ocean or coastwise vessels; or

Eighth—Two years' service as second assistant engineer of lake, bay or sound steam vessels; or

Ninth—Three years' service in the engine department of ocean or coastwise steam vessels, for license as first assistant engineer of ocean steam vessels of 1000 gross tons or under.

In cases where the experience of an applicant for license as first assistant engineer of ocean steam vessels does not meet the specific requirements of this section, other service which the local inspectors consider a fair and reasonable equivalent may be accepted by them in lieu of the service herein specified.

Eligible as Chief Engineer: An applicant for license as chief engineer of ocean steam vessels shall be eligible for examination after he has furnished satisfactory documentary evidence to the local inspectors that he has had the following experience:

First—One year's service as first assistant engineer of ocean or coastwise steam vessels; or

Second—One year's service as chief engineer of lake, bay or sound steam vessels; or

Third—Two years' service as first assistant engineer of lake, bay or sound steam vessels; or

Fourth—Two years' service as second assistant engineer of ocean or coastwise steam vessels; or

Fifth—Three years' service in the engine department of an ocean or coastwise steam vessel, for license as chief engineer of ocean steam vessels of 500 gross tons or under.

In cases where the experience of an applicant for license as chief engineer of ocean steam vessels does not meet the specific requirements of this section, other service which the local inspectors consider a fair and reasonable equivalent may be accepted by them in lieu of the service herein specified.

A candidate believing he has sufficient experience, should first apply to the school nearest to his residence for an application blank, which he must promptly fill out and return.

The United States Shipping Board Free Engineering Schools so far established are as follows: Johns Hopkins University, Baltimore, Md.; Massachusetts Institute of Technology, Boston, Mass.; Stevens Institute of Technology, Hoboken, N. J.; Case School of Applied Science, Cleveland, Ohio; Armour Institute, Chicago, Ill.; Tulane University, New Orleans, La.; University of Washington, Seattle, Wash.; Bourse Building, Philadelphia, Penn.

The candidate is then notified of the action, and if favorable he is advised of the starting date of the next school. The course is four weeks in length and has been up to this time run in daytime only. The hours in school are about six per day for five days per week. The day is divided into three periods, one for engineering mathematics, one for elementary steam engineering and one for laboratory work in allied subjects. Upon completion of the course, the candidate is given an examination, and upon its favorable result recommended to the license board for examination for an engineer's position. Twenty-three men completed the first course at the New York School and twenty secured licenses as engineers, the other three being temporarily debarred on account of errors in their experience records. As a result of the second school, eight out of ten graduates have reported that they have been successful in passing the license examinations. The successful candidates are then recommended to the Sea Service Bureau of the United States Shipping Board so that they may secure employment in the new merchant marine.

The following is a reply by Director Henry Howard, of the United States Shipping Board Recruiting Service to *Power's* inquiry as to his interpretation of item 4 of the Information for Applicants circular sent out by his office. According to item 4 of the circular "a stationary engineer" is qualified to enter the schools; but such engineers who have applied have been rejected because of lack of experience in ships at sea.

I have your letter of Sept. 21, 1917. Since the information circular to which you refer was printed, there have been some changes in the regulations regarding entrance to our classes, and I inclose a copy of a circular letter of the Steamboat Inspection Service, dated Sept. 5, 1917, which gives the latest information relative to admission to the schools.

Referring to the second inquiry in your letter, when a student in our schools completes the course, he goes before the local inspectors for examination, and if he has not had all the sea service required by the regulations of the Steamboat Inspection Service, we endeavor to place him on a vessel, so that the balance of the necessary time at sea may be made up, before he takes his examination. In these cases he is placed in whatever position can be obtained for him. If he has had the required sea service, the inspectors examine him, and if he successfully passes he receives a license. We obtain, as far as possible, positions for these men to serve out their required sea experience, or if they are licensed and not in need of future sea experience in accordance with the rules of the Steamboat Inspection Service, we endeavor to find positions for them, or they are free to find berths for themselves.

The following is the inclosure to which Mr. Howard refers and is a circular letter addressed to the Supervising and Local Inspectors in the First, Second, Third, Fifth, Eighth, Ninth and Tenth districts:

Referring to bureau circular letter dated June 28, 1917, in regard to the campaign that has been undertaken by the Recruiting Service of the United States Shipping Board to obtain licensed officers, and giving detailed instructions with reference to United States local inspectors approving applications for admission to the nautical schools, you will find below, for your information and guidance, copy of a letter dated the 4th inst., addressed to this bureau by Henry Howard, director of Recruiting Service, United States Shipping Board, Custom House, Boston, Mass.:

"The Recruiting Service of the United States Shipping Board is in receipt of many applications from persons who desire to enter our classes, but are short two to six months' sea service, as required by the General Rules and Regulations of your service.

"It has occurred to me that it would be desirable that these men be permitted to enter the classes, and after completing the course, obtain their required experience before making application for license.

"If an arrangement as outlined above can be provided for it will result in securing a number of very good men who might otherwise be discouraged from following the sea.

"If you approve, would you be kind enough to advise all local inspectors that the following applicants may be permitted to enter the classes, providing they obtain the required sea service after completing the course and before making application for license:

"**1. Locomotive or stationary engineers who require six months' sea service.**

"2. Graduates of mechanical engineering from a duly recognized school of technology who require six months' sea service.

"3. Graduates from the engineering class of a nautical schoolship who require six months' sea service.

"4. Graduates of engineering from a duly recognized school of technology who require three months' sea service.

"5. Graduates from the engineering class of a nautical schoolship who require three months' sea service.

"6. Apprentices to the machinist trade who have had three years' service as such and require six months' sea service.

"7. First-class pilots of lake, bay and sound steam vessels of 500 gross tons or over who have had one year's experience as such and require three months' sea service.

"You will note that the conditions described are the minimum requirements of the General Rules and Regulations of the Steamboat Inspection Service and not a departure in any way from the rules.

"Documentary Evidence: There is another point in which we need a slight modification; namely, that we would like to have your inspectors admit men to our schools who have sworn to their statements regarding satisfactory previous sea service, but who cannot produce the necessary documentary evidence. With the clear understanding, however, that before they can take their examinations before the Steamboat Inspection Service, the documentary evidence or affidavits satisfactory to the local inspectors must be produced. This will meet a situation that is bothering us a great deal, without, we believe, in any way affecting your rules.

"If you agree with me, it might also be advisable to allow applicants for deck officer's or engineer's licenses who require two months' sea service to enter the classes.

"If the above changes can be made, and a circular letter be issued to the local inspectors for the purpose of uniformity, I am quite sure it will materially add to the number of available officers for our merchant marine."

You will follow the suggestions made by the director of the Recruiting Service in approving applications for the nautical schools. This does not mean that an applicant for license will be eligible to obtain the same without the proper experience, but it does mean that persons who have not yet had the experience under the conditions referred to by the director of the Recruiting Service will be approved by you for admission to the nautical schools. Before an applicant can obtain license from this service he must, of course, be able to comply in all respects with the General Rules and Regulations prescribed by the Board of Supervising Inspectors, or the discretionary requirements that are vested in you in certain instances. It would be a good idea, in all instances where an applicant has not had such experience as would justify you in approving his application without qualification for license, to make a note of the same, so that when he later applies for license you will be in a position to

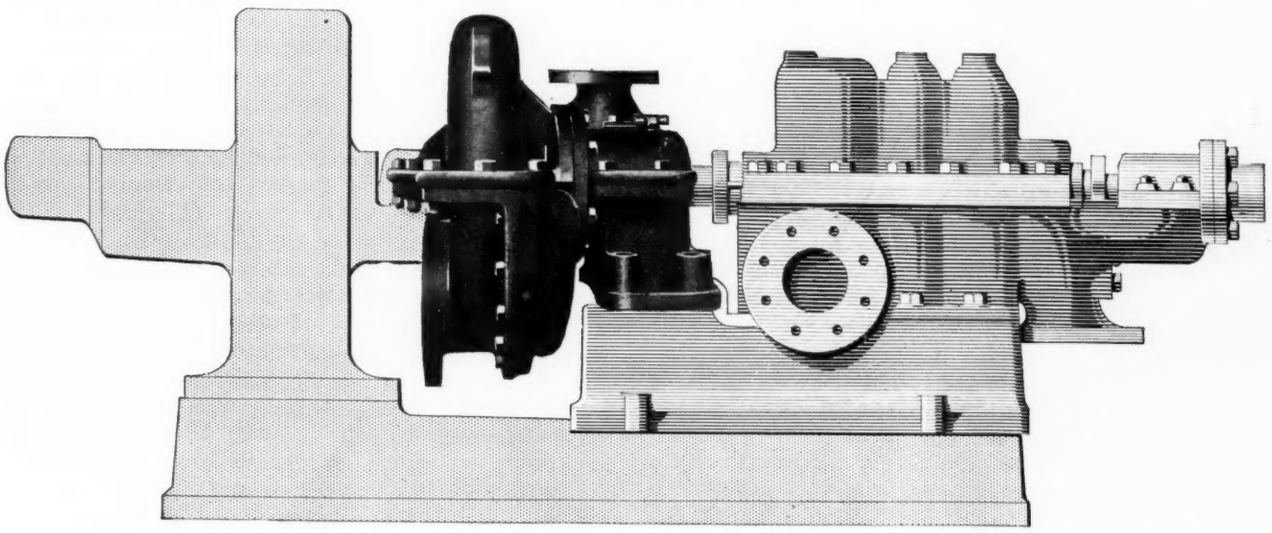
know without delay what further requirements with reference to experience he must have had.

While, of course, the director of the Recruiting Service might have given instructions to the persons in charge of the nautical schools to admit applicants to the same regardless of the experience had by them, it is believed to be a better policy, in view of the arrangements that have already been made, of which applicants are now generally familiar, to have the matter proceed through the local inspectors as above outlined.

D. N. HOOVER, JR.,
Acting Supervising Inspector General.

The Steam Motor

Some radical but logical departures from standard practice are introduced in the new steam turbine put on the market by the Steam Motors Co., Inc., of Springfield, Mass. The Steam Motor, which is the name that the manufacturers have decided to call this machine, differs from the well-known types of steam turbines in that it is not a complete machine in itself. It is furnished with one bearing only and when connected to the driven apparatus, becomes an integral part of the over-all equipment. The objects of the design, as stated by the manufacturers, are as follows:



THE STEAM MOTOR ATTACHED TO PUMP AT RIGHT. STIPPLED PORTION SHOWS ADDITIONAL SPACE REQUIRED BY USUAL THREE-BEARING ARRANGEMENT

1. To make possible a combined pump or blower unit with reduced cost, weight and dimensions, avoiding operating troubles while retaining reliability, sturdiness, simplicity and efficiency.

2. To permit the pump or blower maker to adapt his product without change in design or pattern to the ideal two-bearing steam-driven set, thereby preventing vibration and attendant troubles produced by flexible coupling and misalignment in the three- or four-bearing type set.

3. To meet weight and space requirements in connection with marine installations.

4. To offer a machine for mechanical-drive purposes which will embody all the advantages of the present steam-turbine drive, with the elimination of weaknesses inherent in such units as a whole; a pioneer movement to coöperate in a practical manner with the pump or blower manufacturer.

5. The elimination of everything superfluous on a combined unit, allowing reductions in the cost of the prime mover, driven apparatus and bedplate, and simplifying the complete equipment.

6. To offer various combinations of parts, allowing the customer to furnish the bearing and adapt the Steam Motor by means of a flange to his existing bearing.

The ideal set is one that has only two bearings. If we take, say, a standard pump, remove one bearing and either extend the shaft to carry the turbine wheel or connect the two rotating elements by a solid coupling, we arrive at the solution of the problem.

It is a well-known fact that with a standard three- or four-bearing equipment great care has to be exercised in the alignment of the unit. The so-called flexible coupling is not flexible in the true sense of the word, and for satisfactory operation this must be lined up as accurately as though it were a solid coupling.

Again, no cast-iron bedplate is sufficiently rigid to maintain the alignment from test floor to installation. Of the troubles experienced with these sets after installation, probably 80 per cent. can be traced directly or indirectly to initial misalignment or the settling of foundations, pipe strains, etc.

There are no new principles involved in this machine. The turbine is of the well-known two-row, velocity-stage, impulse type, which authorities seem to agree is the most practicable and commercially efficient for single-stage, noncondensing operation.

One of the weak points in small turbines is the gland. That adopted for the Steam Motor is a modified type of double labyrinth, requiring no lubrication, having no rubbing surfaces, free from upkeep costs due to replacing carbon rings or soft packing and applicable to any exhaust condition, whether it be high back pressure or vacuum.

When the machine is supplied with one bearing, an extra wide self-aligning type of ball bearing is used. The self-aligning feature of this bearing obviates the troubles that were to be expected with the straight, single-row ball bearing when run at high speeds. There is a deflection, and probably a certain amount of whipping, in all high-speed shafts, and unless the bearing can adjust itself to these deviations from the true hori-

zontal, the balls would naturally bear hard and cause vibration and other troubles. The bearing is supplied with a continuous circulation of oil, which keeps it washed out and eliminates the necessity of felt washers and the uncertainty which attends the packing of the average ball bearing with grease. The casing is suspended from a flange at the center. This flange can either be bolted up to the pump or blower bearing or gear casing or connected to its own pedestal. This method of supporting is one which experience has shown to be the most logical way of carrying a turbine casing, as it obviates the raising and lowering of the center line due to expansion following changes of temperature.

For boiler feed, circulating pump, blower and other apparatus not requiring a constant-speed governor an emergency governor only is fitted. This is in duplicate; in other words, there are two distinct, separately adjusted triggers to insure positive shutdown in a case of a runaway. For the field mentioned it is now the standard practice to control the speed by a pressure regulator. In addition to the field covered by the average so-called small turbine, the makers have extended their designs to make the small turbine commercially practicable for very small units from one horsepower up, with a price commensurate with the capacity.

The saving in weight and space over the usual steam turbine of equal power and efficiency is self-evident from the illustration, which is to scale and shows the Steam Motor in the heavy shading, its attachment to a pump in the lighter shading at the right and the space required by the present three-bearing arrangement in the still lighter shading. It has been the object of the manufacturers to supply the customer with only such parts as are necessary for the proper performance of the unit as a whole, with the elimination of everything superfluous, thereby obtaining reduced costs, weight and dimensions of the over-all equipment and at the same time permitting a simple, compact unit driven by steam at one end and handling water or air at the other, with a minimum amount of intervening mechanism.

Motor Would Not Reverse

By E. C. Parham

The angle through which the brushes of direct-current motors must be shifted in order to reverse the direction of rotation of the armature depends on the number of poles in the machine. In all cases the angle is equal to the pole pitch; thus the brushes on a two-pole motor must be shifted 180 deg.; on a four-pole, 90 deg.; on a six-pole, 60 deg., etc. On most modern motors, the brush position is marked on the yoke and bearing housing, so that a mistake cannot be made in the running position. The brush-holder yoke of a repulsion-induction motor is marked for both directions of rotation, and the fit between the yoke and the bearing housing is made loose so that the yoke can be easily shifted should it ever become necessary to reverse the direction.

An operator complained that he was unable to reverse the direction of rotation of a six-pole repulsion-induction motor. He knew enough to shift the yoke to the opposite running mark and he had done so, but the motor would run in the same direction on both marks. Investigation disclosed that the motor was a second-hand machine, the history of which was not available; it was impossible to account for the marking of the yoke, so the determining of a brush position that would give the desired direction of rotation was in order, which was done as follows:

The service voltage was 110, and to keep the starting current to a minimum during the test, the stator was temporarily changed from 110- to 220-volt connection. The compensating brushes were withdrawn and the set-screw of the yoke loosened so that the yoke could be freely moved backward and forward. By closing the line switch and moving the yoke back and forth around the commutator, there was located an energy brush position where the armature would not move in either direction; but on shifting the yoke about one-eighth of an inch in either direction from this locking, or neutral position, the armature would promptly start and operate in the direction of the shift. The neutral position and the new running positions were marked with a chisel. The compensating brushes were then replaced, and as compensation proved to be in the proper direction, the stator was reconnected for 110 volts and the load put on the motor, which operated satisfactorily.

[The trouble related by Mr. Parham was probably due to failure to reverse the compensating-winding leads when the brushes were shifted, and was remedied in locating the running position of the brushes by shifting them 90 electrical degrees from the original location, which would bring the compensating-winding connections correct for the reverse direction of rotation. The type of repulsion-induction motor with a compensating winding, built by one of the large electrical manufacturing companies, when first placed on the market was arranged to be reversed by shifting the brushes about 12 to 15 electrical degrees from the neutral and interchange the compensating-winding leads at the brushes. Later, this scheme was changed to shifting the brushes 102 to 105 electrical degrees from the neutral and not cross the compensating leads, consequently considerable confusion exists on the method of reversing this type of motor. The normal running position of the brushes is 12 to 15 electrical degrees from the neutral if the compensating connections are interchanged, or this distance plus 90 electrical degrees if the machine is arranged to be reversed without interchanging the compensating leads.—Editor.]

The setting of a pop safety valve should never be changed without knowing for what pressure the spring was originally intended. A description of the spring, giving the inside or outside diameter of the coil, and the cross-section, together with the length of spring and size of valve, if sent to the manufacturer will bring forth the needed information. The danger of setting a pop valve without knowing for what pressure the spring was originally intended is that the spring may be too much compressed and the free liberation of steam may be interfered with, if not absolutely prevented, as has been found in some cases. If the pressure is much less than that for which the spring was designed, the valve will not operate satisfactorily. Generally, a safety-valve spring is suited for a 10 per cent. increase or decrease in pressure from that for which it was originally intended, but it is never safe to assume that the pressure to which a valve is set in a given case is the one for which the spring was designed.

Editorials

Frequency-Changer Sets

THE material benefit to be derived from linking up different power stations is well established and is being taken advantage of in many cases. However, the problems involved in interconnecting these stations are of such a nature, and the equipment so expensive and complicated in many cases, as to largely offset the benefits gained by the interconnection.

Before two alternating-current systems can be connected in parallel, they must be alike in voltage, phase and frequency. As far as voltage and phase are concerned, a two-phase and a three-phase system may be tied together through two potential transformers grouped in the well-known Scott connection, and many two- and three-phase systems of the same frequency are operating economically in parallel today, connected by such a scheme. However, where these systems are of a different frequency, then the problem of interconnection takes on a different aspect and can be solved only by the introduction of a frequency-changer set. Although at the present time the tendency is to standardize on 25- and 60-cycle alternating-current systems, a large number of systems are still operating on 40 and 50 cycles, and although not so extensive in use, others operate on 16, 30, 33, 37, 116 and 133 cycles. One has only to consider this conglomerate of frequencies to appreciate the important part that frequency-changer sets are going to take, if electrical power systems are to be tied together on an extensive scale, or small systems of one frequency are to be supplied from the large networks of another periodicity.

Unfortunately, commercial types of frequency-changer sets must consist of two machines having revolving parts. Although there is a certain combination of static transformers that can be used for frequency changing and has not rotating parts, it has not found extensive use outside of the laboratory. There are many other schemes that may be used, such as two rotary converters, or an induction motor driven at different speeds, etc. However, the commercial type of machine used in general is a synchronous-motor-generator set known as a synchronous set, or a set consisting of an induction and a synchronous machine, usually referred to as an induction set.

One of the serious objections to the use of these sets is their low efficiency when compared with a static transformer. The efficiency of the set under the best conditions is only about ninety per cent., as compared with ninety-eight to ninety-nine per cent. for a static transformer. One thing that is frequently overlooked in these sets, however, is that in addition to changing the frequency, they are also capable of taking care of any difference in voltage or phase between two systems, provided the maximum pressure does not exceed 16,500 volts, and the synchronous set can always be used for power-factor correction.

Since so much attention is being given to power-factor correction in present-day power-system operation, and large synchronous condensers are being installed for power-factor and voltage regulation, the low efficiency of the synchronous frequency-changer set is to a very large extent compensated by its power-factor correcting qualities, especially when used to tie two systems together that are not only different in frequency but also in voltage and phase and also require power-factor correction. The efficiency of the set under these conditions compares favorably with the efficiency of transformers combined with a synchronous condenser. In the light of the increasing use of the machines, the two articles appearing in this and a subsequent issue on "Frequency-Changer Sets," by Quentin Graham, should prove of more than passing interest to *Power* readers, since they treat this subject in a practical way not only from a construction viewpoint, but also from the operating end.

Engineers for the Emergency Fleet

TO OPERATE the hundreds of small cargo carriers that are being built to replace the victims of ruthless submarine warfare, many marine engineers will be required.

In order to meet this anticipated shortage the United States Shipping Board Recruiting Service arranged for courses in marine engineering at various technical schools, and stationary engineers and others were invited to attend and qualify themselves. *Power* helped to spread the news of such courses and urged engineers to attend them. Applicants were to support themselves while attending the school, which was expected to cover a period of from one to six weeks. No previous service at sea was stipulated as an entrance qualification. The circular, which was signed by Henry Howard, Director of Recruiting Service, United States Shipping Board, Boston, said: "As soon as a student gets *his license* he will, if selected, go on pay as a junior officer on a coastwise or South American vessel, where he will remain two months, at $75 per month. He will then be at liberty to go on full pay at the rate prevailing in the transatlantic service." The idea was apparently to take stationary and locomotive engineers, engineers on inland waters, machinists with experience on engine work, graduates in engineering, and others having a basic knowledge of engines and their operations, and to give them special instruction pertaining to deep-sea service, and an opportunity to apply this knowledge and accustom themselves to deep-water conditions in a two months' tryout on this side of the Atlantic. It is not at all apparent what was meant by the "license," which we have italicized in the foregoing quotation.

Paragraph 35 of Rule V of the General Rules and Regulations, edition of May 13, 1916, prescribed by the

Board of Supervising Inspectors, under Sections 4405, 4426 and 4441 of the Revised Statutes, says:

No person shall receive an original license as engineer or assistant engineer of steam vessels (except for license as engineer of sawmill boats and pile drivers propelled by steam, and except for special license as engineer of a steam vessel of any kind of 10 gross tons or under on which a licensed engineer is required) who has not served at least thirty-six months in the engineers' department of a steam vessel, a portion of which experience shall have been obtained within the three years next preceding the application: *Provided*, That any person who has served three years as apprentice to the machinist trade in a marine, stationary or locomotive engine works, and *any person who has served for a period of not less than three years as a locomotive or stationary engineer*, and any person graduated as a mechanical engineer from a duly recognized school of technology *may be licensed to serve as an engineer of steam vessels after having had not less than one year's experience in the engine department of steam vessels*, a portion of which experience shall have been obtained within the three years preceding his application.

Numerous engineers who, by reason of *Power's* invitation, have applied for admission to these schools complain that their applications have been rejected because they did not have the requisite sea experience, notwithstanding that no mention was made of sea experience in the circular inviting engineers to avail themselves of the courses. Inquiry for an explanation has brought out the correspondence from Mr. Howard and Professor Pryor reprinted in full on pages 527 and 528. The Recruiting Board at first evidently failed to reckon with the Board of Supervising Inspectors and the existing conditions under its rules as to eligibility for license.

The recent amendments to the Supervising Inspectors' rules to expedite the procuring and training of these men are most commendable. The Shipping Board should not hesitate to cut the legs from under any individual, board or society that delays or seeks to delay the work of getting men to run its ships.

America first; selfish individual interests to the limbo.

The fifth supplement, just issued, to General Rules and Regulations, edition of Nov. 21, 1916, of the Board of Supervising Inspectors, has lessened the required sea experience from one year to six months; however, *a stationary engineer in charge of a 1000-hp. plant is now eligible to apply for a second-class marine license, even though he has had no marine experience.* The New York office of the Steamboat Inspection Service advised over the telephone that the same is true of a man who has had three years' experience as machinist engaged in marine engine-room equipment repairs and installation.

Quite properly, the Supervising Inspectors are cooperating with the Recruiting Service of the Shipping Board, so that now *a stationary or locomotive engineer does not have to have sea experience to be eligible to the nautical and engineering schools* of the Shipping Board. On completion of his course in the school, the man is found a ship on which he may serve the required six months at sea, after which he is eligible to apply for a marine engineer's license and examination by the local Steamboat Inspection Service. Happily, objectionable red tape is now well removed, and stationary engineers have a clearer road to the sea than was true a few weeks ago.

Machine shop experience is a most valuable asset to a marine engineer. Stationary engineers with such experience will, on the whole, make better men aboard ship than those lacking it. These particularly, are the men wanted.

Power from the Air

IT IS recorded that the Lords of the British Admiralty rejected the propeller when it was proposed by Ericsson, and Dr. Lardner demonstrated that a steam-propelled vessel could never cross the Atlantic. In the absence of a demonstration the injector might well have been regarded as a mechanical absurdity, and a proposition to converse across miles of space, without even a wire connection, would have sounded insane a half-century ago.

The open-minded attitude induced by the contemplation of such instances need not, however, lead one to take seriously a proposition to make ten pounds of sugar out of nine pounds of cane, or to take out of a train of mechanism more energy than is put into it.

Garabed T. K. Giradossian, an Armenian mechanic, claims to have invented a "free energy generator." This, he says, is not a perpetual motion, but makes available a free source of energy, by which vessels may be propelled to any distance without stopping to coal up, airplanes may fly around the world and carry thousands of pounds, torpedoes may be projected at great speed, and the speed of steam engines doubled (although it is not apparent what we should want of the poor old steam engine any more).

We have a great admiration for Garabed T. K. Giradossian, not as an inventor, for our office is the depository of countless schemes for the multiplying of power and evading the law of the conservation of energy, but as a promoter. In *Power* for July 31 was told how he had appeared before the House Committee on Patents, which issued twenty-five pages of printed report about his invention and various subjects more or less touching on and appertaining thereto. The committee has now reported a bill which went through both houses of Congress with a whoop, providing that the device shall be tested by a board of five scientists to be selected by Mr. Giradossian and approved by the Secretary of the Interior.

Every once in a while somebody discovers that water is a combination of oxygen and hydrogen, and declares that all that a vessel has to do to secure an unlimited supply of fuel is to decompose some of the water upon which it is floating and burn the hydrogen that is produced with the oxygen from which it has been separated. The trouble is that the water is the product of a previous combustion of hydrogen—a union of hydrogen and oxygen—and that it takes just as much energy to separate them as they generate in coming together, just as it takes as much energy to hoist a weight as it will give back in falling.

Is there any reason to hope that Mr. Giradossian's project has any firmer foundation?

It cannot be said that Mr. Giradossian's dream is impossible of realization. The process is going on continually before our eyes. Carbon, in its various forms of coal, wood, charcoal, oil and other fuels, is burned by combination with oxygen, the product of the complete combustion being carbonic-acid gas. To decompose a pound of this gas would require as much energy as would lift a ten-ton weight over one hundred and fifty feet, but here comes in one of the most wonderful, beautiful and mysterious of nature's processes. It is a peculiar property of vegetation that under the influence of sun-

light it can overcome the attraction which exists between the atoms of carbon and oxygen, appropriating the carbon to its own use, building it into its structure, and letting the oxygen go free into the atmosphere.

To separate these two elements in our laboratories, we are obliged to resort to the most powerful chemical agents and to conduct the process in vessels composed of the most refractory materials, under all the violent manifestations of light and heat; and we then succeed in liberating the carbon only by shutting up the oxygen in a still stronger prison. But under the quiet influence of the sunbeam in that most delicate of all structures, a vegetable cell, the chains which unite together the two elements fall off, and while the solid carbon is retained to build up the organic structure, the oxygen is allowed to return to its home in the atmosphere. To separate a pound of carbon from the oxygen with which it unites in burning would require the expenditure of an amount of energy which would raise the weight of a ton to the height of over a mile, and yet in the economy of nature this process is constantly going on, not with the noisy demonstration of prodigious effort, but quietly, in the delicate structure of a green leaf waving in the sunshine.

Has the Armenian mechanic discovered the secret of the vegetable cell?

A Good Time to Stop Profiteering in Coal

PURCHASERS of coal who are convinced that they are being charged exorbitant prices should make a formal complaint to Dr. H. A. Garfield, Fuel Administrator, 1026 Sixteenth St., N. W., Washington, D. C., stating the essential details of the transaction, to insure an investigation which, if it develops guilt on the part of the dealer, will be followed by prosecution under the food and fuel act.

The penalty, as provided in the food and fuel bill, is that "whoever shall, with the knowledge that the prices of any such commodity have been fixed . . . violate or refuse to conform to any of the same, shall, upon conviction, be punished by a fine of not more than $5000, or by imprisonment for not more than two years, or both."

"Each independent transaction," the bill continues, "shall constitute a separate offense."

Also, if the fuel administration believes the action advisable, a firm's business may be requisitioned and operated by the Government for the remainder of the war, the owner having recourse to the regular procedure of the courts to sue for the compensation to which he believes himself entitled in the course of his business.

"Local committees to handle the coal price situation will be formed soon," Dr. Garfield says. "They will work with the state fuel administrator, who in turn will work with the fuel administration in Washington. Then it will be necessary only to take up all questions of price with the local committees, which if possible will adjust the matter themselves or in other cases carry it up to the state administrator."

The determination of the people to make the operators and handlers furnish coal at cost plus a fair profit is natural, commendable and capable of execution. Be patient and help to do it.

As our forces in France increase so will the problem of keeping them supplied with fresh and wholesome food. This will necessitate the construction of large refrigerating plants behind the lines and, in turn, will require operators familiar with such equipment. Here is another opportunity to serve.

"Smokeless firing and intelligent firing are almost synonymous, although there are conditions under which smokeless firing is impossible, regardless of the care and intelligence exercised by the firemen," said J. T. Anthony in a paper before the Smoke Prevention Association. There are many engineers who would do well to recall this statement when about to "bawl out" their firemen for smoke-belching stacks.

Advocates of all-welded piping systems will be pleased and others interested to know that a brewery having a very extensive suction-gas (ammonia) piping system, has just completed remodeling the system, welding the whole to do away with joints. Oxyacetylene was the process used. The progress in the field generally is indicative that the days of flanged headers, receivers, manifolds, etc., as well as piping systems with numerous flanged joints, are soon to pass away.

We have not heard anyone talk recently about the limit in capacity of steam turbines. Though it was a popular pastime a few years ago, there seems to be no latest guess. What will be the limiting factor—peripheral speed, blade length, materials or transportation facilities? And that brings up the interesting question: With the reliability of the turbine depending upon a steam trap, an auxiliary or labor in the auxiliary room, how much capacity is it safest to put in one machine and keep the reserve capacity within reason?

The success of the Liberty Loan lies not in the ultimate getting of the money, but in a prompt, generous and universal response. Numerous small contributions are better than a single one of the same aggregate amount. The money invested is safer than in a savings bank, will draw interest until it is paid back, and the bond can be reconverted into cash or used as a security at any time. The limit is so small that anybody can get in. You can get one of your bank, at the post office or of your employer. Buy one today, and show the boys who are going to the front that there is no lack of willing and earnest support behind them.

To compromise happily is to succeed. If there had been fewer words and more action by the conservation and the monopoly crowds in Congress, we might today have enough developed hydro-electric power to make less severe the coal situation. And there might have been plants sufficiently near rail facilities to furnish adequate power for the nitrate industry which the Government will now have to pay millions more to develop. Nitrates are needed, and needed quickly, for war purpose. Time does not permit of waiting for the completion of hydro-electric projects, and to commandeer the output of stations now in suitable locations but supplying industrial districts would be military as well as industrial suicide. Yes, as usual, the horse is gone and the door swings wide on its hinges.

Correspondence

Carbon Versus Tungsten Lamps

Efficiency and economy are today the two great needs not only of each individual but of the entire nation, and it is therefore highly important that we should all give them our serious attention.

So much has been said about the great economy of using tungsten filament lamps instead of the old-style carbon and metallized-carbon filament type that it should not be necessary to dwell upon this subject, but the fact that approximately one-sixth of the domestic lamp sales for 1916 were carbon and metallized-carbon lamps, as pointed out in your editorial columns, June 26 issue, makes a further discussion justifiable.

At the present time there appear to be only two reasons offered for the use of the carbon and metallized-carbon lamps—their lower first cost and the fact that they are more rugged for rough work than tungsten lamps, thus keeping down the renewal cost. As for the original cost of the various lamps, there is not such a large difference. For instance, the present list price of a 50-watt carbon lamp is 16c., a 50-watt metallized-carbon lamp 20c. and 50-watt tungsten lamp 27c. With a great many people this first cost seems to be the deciding factor; they do not appear to realize that the purchase price of a lamp is a very small percentage of the total cost of the current consumed by the lamp during its rated life. However, the fact remains that the tungsten lamp gives approximateiy three times as much light for the same wattage consumed as the carbon lamp and approximately twice as much light as the metallized-carbon lamp. Considering that the average life of a lamp is about 1000 burning hours, then the average cost of the current consumed by the lamp is several times greater than the original cost of the lamp. For example, the list price of a 50-watt tungsten lamp is 27c., while the cost of the current consumed by this lamp based on 8c. per kw-hr. for 1000 hours is $4. Since this lamp gives approximately three times as much light for the same current cost as the 16c. carbon lamp, it is easily seen that considerable money would be saved even if the carbon lamp is given away.

Carbon Lamps for Rough Work

As for the second excuse offered, for using carbon lamps in preference to tungsten lamps for rough work where considerable breakage is experienced, resulting in higher renewal costs, it will be found that the method of using is almost always at fault and not the lamp itself. The fact that tungsten lamps give such long service on trolley cars, where considerable vibration is experienced, proves that this lamp is very durable. About the roughest usage to which lamps are now put is on the end of drop cords that are handled by the workman or that come so close to his work that they are likely to get hit. Instead of criticizing the lamps in such a case, it is the system of having drop lamps that should be criticized.

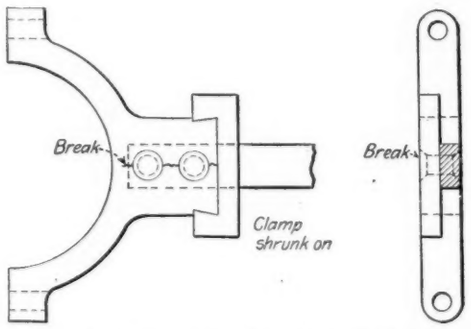
According to the best illuminating engineering practice in factories, drop lights have been almost entirely superseded by the system of having more general illumination and having any local illumination that may be necessary out of reach of the workmen, thus relieving the lamps of rough handling. The real up-to-date factories or workshops have done away with the old method of drop lamps and have therefore eliminated the possibility of the lamp being subjected to rough usage. Therefore it is evident that the use of the old-style carbon and metallized-filament lamps can be greatly reduced by installing better lighting systems, employing the use of tungsten lamps. This will be a far-reaching step in the interest of efficiency and economy.

L. Cummins.

New York City.

Eccentric Strap Repaired

The eccentric strap on a hoisting engine broke, and not being able to procure a new one for some time, the old one was patched as shown in the illustration.



WHERE STRAP WAS BROKEN AND HOW REPAIRED

It was such a secure-looking job when completed that we decided a new one was not necessary, and to my knowledge the repaired strap did service for three years and apparently was good for many more.

Arthur, Ill. E. S. Ray.

Hints on Babbitting

When babbitting a solid bearing, put a little white lead on the mandrel and no trouble will be experienced in removing it after the metal is poured. When the babbitt space is quite thin, put a little rosin in with the babbitt, and it will pour true and even.

The metal of the shell and the mandrel should be thoroughly heated before the metal is poured, to avoid chilling and excessive contraction of the babbitt away from the shell.

J. B. Tait.

Angox, B. C., Canada.

Relative Economy of Steam Pumps

On page 267 in the issue of Aug. 21 there is an inquiry as to why the single direct-acting steam pump is more economical of steam than a duplex. The explanation given is that the duplex has a larger percentage of clearance space. This is, of course, true, but it is only one of the causes.

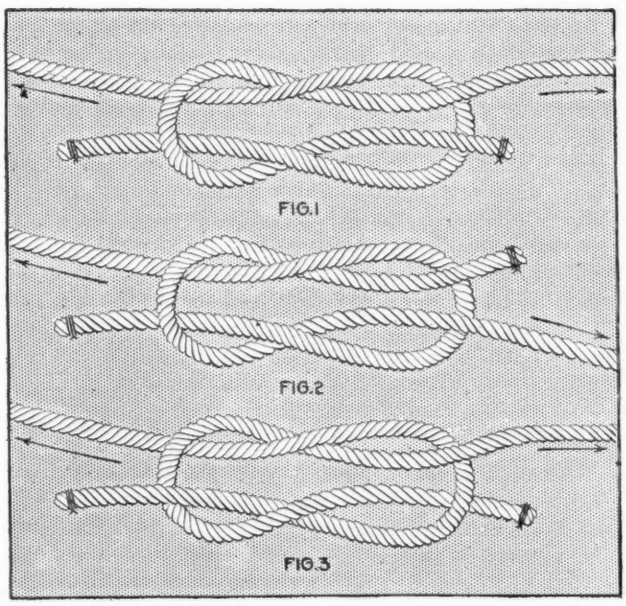
The principal reason is that the single pump always operates full-stroke, whereas a duplex will have one side and possibly both sides short-stroking, thus adding very considerably to the clearances and increasing the amount of steam necessary.

J. D. CONE,
Assistant General Sales Manager,
A. S. Cameron Steam Pump Works
New York City.

[All of which is comprised in the answer given—greater clearance.—Editor.]

Deceptive Similarity in Knots

A description of an unusual knot called the "thief" is given in a small handbook on military work, and that is the only place I have been able to find it mentioned. While it is likely to be tied by chance only, the fact that it is possible to do so and if it is trusted to hold will cause somebody grief seems sufficient reason for calling attention to it.



ONE GOOD AND TWO BAD KNOTS
Fig. 1—The square knot. Fig. 2—The "thief." Fig. 3—The granny or rolling knot

Fig. 1 shows the ordinary square or reef knot. Fig. 2 shows the "thief"—presumably so called because it looks so much like the square knot, so well-known and reliable. I have called the attention of more than a dozen engineers, structural men and riggers to the "thief" and failed to find one who had ever seen it described; most of them thought it would hold, but a trial soon showed that it would slip. The difference is entirely in the point of pull, which is on the same side or half of the knot in one and on the opposite sides in the other. The way in which the "thief" is most likely to be tied is when one bend or bight is made and the other end threaded through it. Fig. 3 is the "granny" or rolling knot and, like the "thief," will not hold. The difference between this and the square knot is that when the ends are brought back for the second half of the knot, they are crossed over. All that needs to be remembered in tying a square knot is to bend the ends back on the same side as they occur after the first half of the knot is made, so that the rope and the end lie on the same side of the loops. To avoid the "thief," see that the pull comes on the lines on the same side or half of the knot.

O. R. MCBRIDE.
Pittsburgh, Penn.

Imprisoned in a Boiler

The story on page 403 in the issue of Sept. 18, of the man imprisoned in a boiler, reminded me of an experience I had about thirty years ago when serving as second engineer on a large tugboat stationed at a North of England port.

The boat had two Scotch boilers with two furnaces each and, after cleaning them one Sunday, we had made ready for the water boat to come alongside and fill the boilers with fresh water. The water-boat men did not work on Sunday, so we had arranged for them to come at 1 a.m. on Monday, and to facilitate the work we had secured one end of a length of our own hose in the top manhole of one boiler and left the free end on deck so that they would only have to connect their hose to ours and start their pump, and as the boilers were cross-connected by the bottom blowoff pipes, both would fill at the same time. Having so made ready, we all went home. We had no watchman except the one on the dock, as the vessel was owned by the dock company.

During the evening, while thinking over the day's work, I could not account for a large monkey wrench that had been used, but felt sure it had not been returned to its place in the tool rack. Fearing that it had been left in the boiler and might cause trouble, I determined to go down to the boat and investigate. I reached the vessel about 9 o'clock, and sure enough, the wrench was missing. I got into an oversuit and, taking a lighted torch, got down into the port boiler and soon found the wrench on the bottom. Without stopping to consider, I slipped down between the side of the furnace and the boiler shell, secured the wrench and placed it with the torch on the internal feed pipe within reach from the top of the furnace.

I then started to climb out, but that was easier said than done. I had got quite warm with my exertions, and struggle as I would, I could not force myself up through the narrow space. I got all excited and my nerves were on edge. I tried every way I could think of and then shouted myself hoarse, but all to no purpose as no one could hear me. Then there came the reflection that presently the water boat would come, but could attach to our hose and fill up the boilers without having to come below deck where I could make them hear. I mentally consigned the designer of the boiler to Sheol because I could not think of a worse place, and paid my respects to my own stupidity in getting down that way instead of taking off the bottom manhole cover.

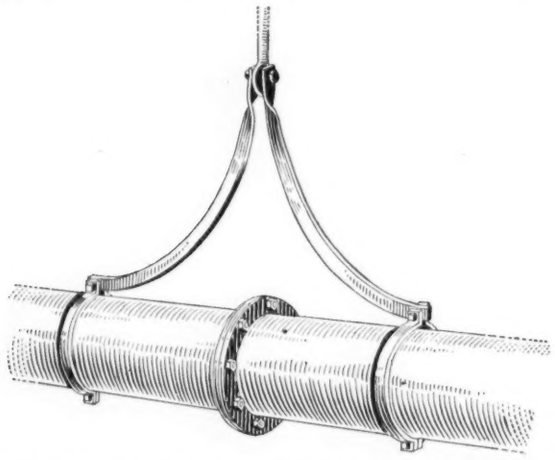
When completely exhausted by my struggles, I lay down on the boiler bottom and cooled off a bit. Presently my "thinker" had cleared somewhat, and I began to consider the situation from a common-sense point of view. I reasoned that I could not have grown larger naturally in the short time I had been in the boiler and also that the space could not have contracted, so there was only one conclusion—that I was swelled up by the heat and my strenuous exertions and the state of my nerves.

I soon decided on a new course. I wriggled myself out of my scanty garments, which I rolled up and placed on the feed pipe with the wrench and torch. I then lay on the cold boiler bottom until I got so cold I could hardly move, when I decided to make another effort carefully and with as little exertion as possible. I worked my way up, and in a few minutes was on the outside of that boiler, considerably wiser than when I entered it. I had learned two lessons, never to be forgotten—not to go into any place of that kind without a companion near-by and not to get excited until I had thought the situation over carefully. J. W. LEA.

Philadelphia, Penn.

Support for Flanged Pipe

The illustration shows a support for flanged pipes, which I find satisfactory. Some pipefitters, in putting up large pipes, allow long spans in the line to go unsupported, and a great strain is put on the flanges.



SPECIAL FORM OF SUPPORT FOR FLANGED JOINTS

I prefer to use two clamps, one on each side of the flange, bolted tight to the pipe, joined by two V-shaped pieces as shown, to remove the strain from the flanges and prevent the pipe from sagging. A. J. CAHEN.

Brooklyn, N. Y.

Improved Operating Record

Facing the problem of a 100 per cent. increase in fuel oil, the operating force of a small plant furnishing light, heat and power for an institution determined to coöperate in an effort to increase the efficiency of the plant. The only instruments available were the wattmeters, telltale in the fuel-oil tank, steam recording gage and five thermometers (three in the feed-water line and two in the flue-gas passage). It was a rather discouraging problem.

Two of the four boilers were generally sufficient to carry the load. A three days' test operating the boilers separately, one for the engine and the other to supply the steam for heating, kitchen and laundry work, showed the engine load to be approximately one-third of the total, and figuring the kilowatt output with the present price of fuel oil, the result was favorable; but the price of fuel oil was soon to be about doubled and the central station would be able to make an attractive offer, so the only course was to improve operating conditions as much as possible.

Method of Draft Regulation Changed

The first step was to discontinue the use of the ash-pit doors for draft regulation and to equip the breeching dampers with cables extending to the boiler front, but the gain was not so great as was expected; in fact, it was hardly noticeable, because the flue-gas temperature at the entrance of the economizer averaged only 435 deg., showing that the loss from that cause could not be excessive. The 70-ft. unlined stack, with an average temperature of 340 deg. at its entrance, could not develop a draft at its base of over 0.35 in., and considering the tortuous passages through the economizer (three right-angled turns all told), a short run of rectangular-shaped breeching, it is seen that the drop in the settings must have been very small; and as the boilers were operated at near capacity the greater part of the time, it is evident that that method of draft regulation was of little importance, as there was seldom an excess of draft. This plant's efficiency would probably have been far less had a greater draft been available, for "green" men were frequently broken in as firemen and were exepected to clean boilers and do odd jobs about the plant, besides regular fireman's duties, and if they succeeded in keeping water in sight, the safety valves from popping and a smokeless stack, they were considered good firemen. As for regulating the draft, the average housewife pays more attention to damper regulation than is customary in many of these small plants.

Soot and Ash Formation a Source of Loss

Another source of loss usually overlooked is soot or ash formation, it being generally believed that as long as there is no smoke no soot will form on the heating surfaces; but the ash in heavy crude oil collects on all portions of the heating surface regardless of the temperature, and its presence in any amount is detrimental to heat transfer. In the plant referred to it had been customary to dust the boilers at the end of each run (six weeks). As an experiment, however, the two boilers while in operation were dusted and the fuel consumption for the day dropped considerably below the average for the preceding week; so it became the practice to dust the boilers every other day. The next move was to boil out both sides of the closed-feed-water heater with a solution of caustic soda. This resulted in an increase in feed-water temperature from 172 to 192 deg., nearly 2 per cent. saving.

The economizer made up of 20 sections of 5 tubes each came next. The usual cleaning had been limited to removing the caps from the upper header and washing out the rear tubes and lower headers with a hose every two or three months, which means that in the ten

years of its use nothing had ever been done to remove the oil and sludge from the other four vertical tubes in each section. But a still greater problem was the removal of the hard glazed soot and ash formation, from ¼ to $\frac{5}{16}$ in. thick, on the exterior of the tubes. After bypassing the gas and water, several men were set to work with light hammers and scrapers in an attempt to remove the formation from the outside of the tubes. After two days it was realized that this method was hopeless so the exterior of the tubes was swabbed with a solution of navy boiler compound, which seemed to soften the glaze somewhat, after which a hose was connected to the feed-water line and the tubes were washed with a stream of hot water under a pressure of 125 lb. The result was promising, so the hose was connected to the compound feeder and a solution of navy compound and hot water was applied under full pressure. The results were surprising, and after intermittent washing continuing throughout one day, the last particle of the glaze was removed, leaving the tubes throughout as clean as when first installed. A half-barrel of caustic soda was then dissolved and put in, and the economizer was filled with water, the flue gas turned in and the water allowed to boil for six hours, keeping just enough water running in to make up for the loss by evaporation through the upper header. It was then emptied and refilled with clear water and boiled for another hour, after which all traces of oil and sludge were gone, leaving the interior as clean as new. When put in service, the temperature of the feed water was found to average 243 deg., which was an increase of 20 to 25 deg. over the previous average, thus effecting another 2 per cent. saving; and there was a drop of 30 deg. in the flue-gas temperature at the economizer outlet.

It may be asked why a regular boiler test was not run to determine the evaporation. This was not done partly because the returns from the laundry were pumped directly to the boilers through a separate feed line, and the management would not purchase the necessary equipment for a test. As a result of the foregoing, however, the daily fuel consumption is, as nearly as can be calculated under the varying conditions, about 6 or 7 per cent. lower than before. C. M. ATKINS.

Denver, Colo.

Fires in Transformers

In an article in the Sept. 18 issue of *Power*, relating to "Fires in Transformers," by M. A. Walker, it was stated that one of the methods for quenching a fire in transil oil inside a transformer was to use carbon monoxide (CO). Now CO gas has a very low combustion temperature; that is, it is an inflammable gas. Evidently the writer had in mind carbon dioxide gas (CO_2) which is a non-inflammable gas and is, in fact, a very good fire extinguisher.

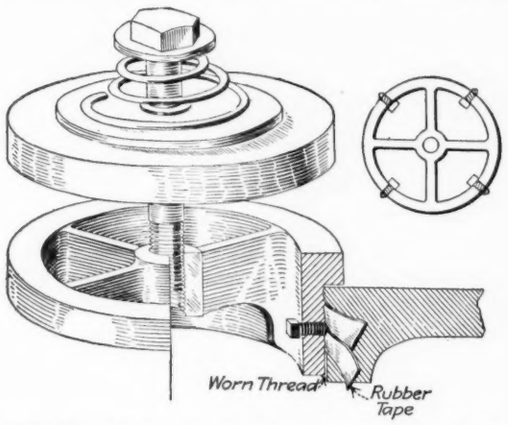
Another method for quenching a fire inside of a transformer, which could be easily installed and is not expensive and which would introduce no liquid or gas inside the casing, would be to fit a small valve on the transformer cover, connected to a pipe leading to a vacuum pump or system. When fire occurred inside of the transformer, the air inside could be kept rarefied and the fire soon would go out owing to lack of oxygen.

New York City. V. J. KUBANYI.

[Outside of the mechanical stresses that the transformer tank would be subjected to, due to exhausting the air from the space over the oil, there are the effects that low atmospheric pressures would have toward increasing the rate of evaporation of the oil, creating a dangerous condition by liberating large quantities of highly explosive gases. It would be interesting to have the opinions of *Power* readers on this subject and to know if such a scheme has ever been tried.—Editor.]

Loose Pump-Valve Seat Secured To Prevent Shutdown

Quick repairs are sometimes necessary in order to avoid an expensive shutdown, and in many cases a simple remedy applied quickly will keep things going until there is time to make permanent repairs. A few days ago the boiler-feed pump suddenly refused to supply enough water for our three boilers. I found one of the suction-valve seats entirely out and the threads in the valve plate completely corroded away, leaving



SETSCREWS TO HOLD VALVE SEAT IN PLACE

nothing to hold the valve seat in place. It was necessary to get the pump in working order as soon as possible, so I drilled and tapped four holes through the side of the valve seat, midway between the ribs for quarter-inch setscrews. I then wrapped two turns of insulating tape around the valve seat, drove it to a solid seat in the valve plate and tightened up the setscrews. This gave satisfactory service until I could make permanent repairs. J. W. STANLEY.

Braemar, Tenn.

Engineers' Hours and Duties

I disagree with C. R. Reynolds who, in the issue of Sept. 4, page 334, says that the engineer is on the job 12 out of the 24 hours and sometimes longer. This is not the case with all engineers, as the majority work less than 12 hours, although many work every day of the week. In an emergency of course it is all right to work long hours.

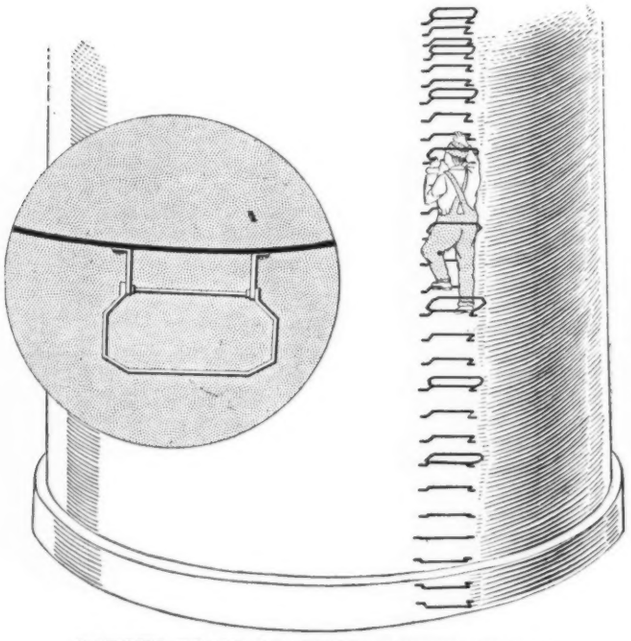
I do not think the engineer should be made a "Jack-of-all-trades" as Mr. Reynolds would have us believe, and as for getting to the top of the ladder, it will never be reached by the "flunky" route.

Mascoutah, Ill. THOMAS B. CARPENTER.

Safety Ladder for Smoke-Stacks

Ladders built on the outside of smoke-stacks have little attraction for the fellow who has to climb them occasionally. I recently saw one, however, that looks good to the man who has climbed an ordinary ladder to the point where he keenly realizes that his "dear life" depends entirely on his muscles, and has then climbed on to the point where he realizes that his muscles are failing and quivering from sheer exhaustion. To stand still is only a little less exhausting than to go on climbing.

Then and then only one is in a position to fully appreciate the value of a ladder inclosed in guards, as shown in the illustration. It is almost impossible to fall from this ladder, as the enveloping hoops or guards are not more than three feet apart, so at no time is a man's body entirely devoid of protection. The hoops are large



LADDER PROVIDED WITH SAFETY GUARDS

enough to give plenty of clearance when climbing, yet small enough so that one can lean back against them in perfect safety while resting hands and arms. A fall from such a ladder is practically an impossibility.

The brick-lined steel stacks to which these ladders are attached are noteworthy in themselves. Extending 120 ft. above a fourth floor roof, they are 23 ft. in internal diameter and required 600 tons of steel for their construction. H. B. McDERMID.

Buffalo, N. Y.

The "Why" of High Vacuum for Turbines

In reference to Mr. Mason's letter on page 366 in the issue of Sept. 11, "Why does it pay to spend large sums of money for special condensing machinery to get an extra-high vacuum for a turbine—and not pay to do the same for a reciprocating engine?" I take it that the point to be brought out by the question was one of comparative specific volumes of steam under the two conditions of vacuum.

The specific volume (or volume in cubic feet) of one pound of steam at 26 in. vacuum is about 173.5 cu.ft., while at 28 in. it is 333 cu.ft. Thus it will be seen that one pound of steam at 28 in. requires nearly 92 per cent. more space than at 26 in. vacuum. This would mean that the sizes of the ports and steam passages of the low pressure cylinder of a reciprocating engine working under a high vacuum would need to be of extremely large area to permit the free flow of such rarefied steam. The steam consumption of a reciprocating engine is decreased less by a certain increase in vacuum than is that of a turbine, and the gain in economy being much less is overbalanced by the additional cost of obtaining the higher vacuum.

Therefore it seems to me the answer is: "First and most important, because the greater specific volume of steam under the high vacuum would require excessively large cross-sectional areas on the vacuum end, and second, that the increase in economy under high vacuum is much less with the reciprocating engine than with the turbine and does not warrant the extra cost of obtaining it." JOHN A. COLLINS, JR.

Lawrence, Mass.

Fuel from Wood Wastes

I am pleased to notice that, in the current issue of *Power*, you are giving prominence to the necessity for the abatement of smoke in our cities. We have solved the problem in two ways in British Columbia. First, we have a hand-fired furnace which cannot smoke when properly operated, and secondly, we have succeeded in manufacturing a splendid smokeless fuel from the wastes of wood, of which I inclose a number of analyses:

	Moisture	Volatile Matter	Fixed Carbon	Ash	B.T.U. per Lb.
British Columbia government analysis	3.00	3.50	90.00	3.50	13,740
Vancouver Portland Cement Co., Ltd	....	7.00	89.45	3.55	.....
A. H. Maude, A.I.C	3.81	....	.....	2.70	13,800
					Calories per Kg.
British Columbia Sugar Refinery Co., Ltd	2.99	....	94.04	2.97	7,600

The source of supply for this fuel is not limited to wood wastes from sawmills, logging operations and land clearing. The wastes peculiar to any locality, including those from straw, cotton, rice, sugar, hemp, etc., will, with variations in the process, give a fuel of practically the same composition.

Lumbermen state that at a conservative estimate 150,000 cords of wood are wasted daily on the Pacific Coast. This would make 13,000,000 tons of the new fuel annually, the conservation of which would be a considerable item in these times. This process should not be associated with briquetting. It is an artificial fuel made by a short cut on nature's process of converting vegetable waste into coal. WALTER THOMAS.

Nanaimo, B. C.

There seems to be a serious shortage of engineers to operate CO_2 refrigerating machines aboard ship. A lot of operators of steam-boiler plants have not achieved success in increasing the output of that same gas. And by the way, what is being done about utilizing or storing the CO_2 from steam boilers? Isn't it a valuable by-product?

Inquiries of General Interest

"Square" Engine—What is meant by a "square" engine? J. W.

The term is sometimes loosely employed with reference to engines that have the piston diameter equal to the stroke; for instance, "6 in. square" like "6 by 6," signifying 6 in. diameter of piston and 6 in. stroke.

Stretched Position of Corliss Valve Rod—In a Corliss valve gear, what is meant by the stretched position of a valve rod? G. C.

The term is applied to the position of a valve rod when it is in line with the center of the wristplate stud. For that position, the valve rod will be on a dead-center with its wristplate pin and the valve arm will have the valve moved to the extreme closed position obtainable from motion of the wristplate.

Return Crank—What is a return crank and for what purpose is it used on an engine? R. A.

The term "return crank" is employed to designate a crank arm secured to the end of a crankpin of an overhung single crank, from which it projects for carrying a crank that usually is at an angle with the main crank and has different throw of crankpin. This type of overhung crank is sometimes used for imparting principal motion to a valve gear, especially in cases where it is not practicable to obtain the motion from an eccentric placed on the shaft, as in the common application of the Walschaert valve gear to locomotives.

Arrangement of Hot-Water Tank and Connections—For heating water to be drawn under pressure from a closed tank that is connected with a cold-water supply under pressure, how should the tank be placed and connected to the heater? T. J. O.

To insure circulation, the tank should be above the heater and the flow pipe from the heater should rise continuously toward the tank and be connected into the side of the tank. The cold-water supply should be connected to the lower part of the heater with a bypass connection to the lowest part of the tank, and the hot-water supply should be taken out of the top of the tank.

Use of Injection Water with Oil Engines—What benefit is derived from use of injection water in the operation of an oil engine? A. M. P.

In some low-compression oil engines, such as those that employ hot-bulb ignition, water injection is used to prevent preignition. More power is usually obtained, not from any thermal advantage, but because it is possible to further load the engine without preignition. The advantage is sometimes attributed to the expansive force of the steam generated. This, however, seems unlikely, for the heat required for evaporation of the water would, if anything, be employed to better advantage in increasing the expansive power of the products of combustion.

Spacing of Boiler Tubes—In a horizontal return-tubular boiler how much space should be left vertically between flues for circulation of the water? G. T. L.

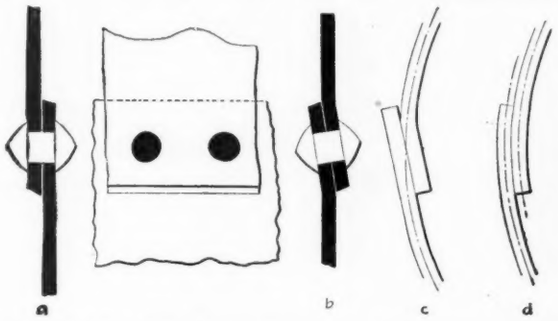
The vertical and horizontal spaces between tubes should never be less than ¾ in. in the clear, and when possible the horizontal ones should be made at least 1 in. with a vertical circulation space at the center of at least 2 in. For ordinary sizes of power boilers, the vertical spaces are commonly made 3 to 4 in. If the channel through which the circulation takes place is too narrow, the progress of the water is arrested and disengagement of steam is accomplished with shocks. On the other hand, for a given size and proportions of a boiler the circulation spaces may be too wide for some rates of firing, causing local ascending and descending currents to be set up, which interfere with one another.

Boiler Horsepower Required for Heating—With boiler-feed water at a temperature of 200 deg. F., what number of boiler horsepower would be required to supply 7500 sq.ft. of wall coil radiators with live steam at 8 lb. gage pressure in maintaining a room temperature of 65 deg. F. where the condensation is discharged by traps? B. N.

The temperature of the steam would be 235 deg. F., and the difference of temperature would be 235 — 65 = 170 deg. F. The average amount of heat given out per square foot of radiator surface would be about 1.7 B.t.u. per hour per degree difference of temperature, and the total amount of heat liberated would be $170 \times 1.7 \times 7500 = 2{,}167{,}500$ B.t.u. per hour. If the condensation is discharged by traps, only the latent heat of the steam would be realized, namely, about 955 B.t.u. per pound of steam, and therefore $2{,}167{,}500 \div 955 = 2269$ lb. of steam per hour would be required. The total heat of a pound of steam at 8 lb. gage pressure, or about 23 lb. absolute, is 1158.8 B.t.u. above 32 deg. F., and when generated from feed water at 200 deg. F., each pound of steam would require 1158 + 32 — 200 = 990 B.t.u. A boiler horsepower is equivalent to evaporating 34.5 lb. of water per hour from and at 212 deg. F., or the latent heat of evaporation at atmospheric pressure; namely, 970.4 B.t.u. per pound. Hence to supply the heating coils under the conditions stated, would require development of $\frac{2269 \times 990}{34.5 \times 970.4} = 67.1$ boiler horsepower.

Beveled-Lap Boiler Joint—What is a beveled-lap boiler joint and what are its advantages over an ordinary lap joint? L. F.

When an ordinary lap joint such as shown in section at *a* is subjected to tension in direction of the plates, there is a tendency to distort the joint as shown at *b*. This tendency may be partly relieved by bending the plates to the distorted form before they are riveted together and, when so constructed, the joint is called a beveled-lap joint. Its disadvantages, compared with a plain lap seam as shown at *a*, are that the rivets are subjected to tension as well as shearing and there is considerable bending action, with much greater tendency to open the joint and cause leakage.



The beveled-lap joint has advantages for use as the longitudinal seam of cylindrical shells like circular firebox sheets that are subjected to a collapsing pressure that is best resisted by true circular form. With a beveled-lap joint the circular form of the shell may be made continuous through the joint, as shown at *c*, whereas with the plain lap joint the sheets are eccentric, as shown at *d*, and the construction does not admit of true circular form.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Effect of Brick Arch on Smoke Abatement*

By J. T. Anthony†

[While the following relates to locomotives particularly, it will be realized that the various conditions influencing combustion apply also to stationary boilers.—Editor.]

The Master Mechanics' Proceedings of 1913 contains the report of the smoke committee appointed by the General Managers' Association of Chicago, which states that "while running, the brick arch is capable of making a 50-per cent. reduction in smoke, irrespective of steam jets."

The tests upon which this statement was based were run with Penn gas coal of the following composition: Fixed carbon, 57.74 per cent.; volatile matter, 34.07 per cent.; moisture, 1.05 per cent.; ash, 7.14 per cent.; B.t.u. per lb. of dry coal, 14,520. The smoke reduction of 50 per cent. was accompanied by an increase in evaporation of 8.6 per cent. due to the arch.

Performance with Brick Arch

The Chicago Smoke Commission (of which Dean Goss was chief engineer) made extensive tests, with and without the arch. They found the brick arch to achieve the following: Decreases the average density of visible smoke emissions, 33 per cent.; decreases the total average quantity of cinders and fuel dust emitted in smoke, 25 per cent.; decreases the amount of carbon contained in cinders and fuel dust per ton of coal consumed, 24 per cent.; decreases the amount of ash contained in same, 28 per cent.; decreases the volume of air intermingled with gases of combustion discharged through stack, 15 per cent.; increases the volume of CO_2 discharged through stack, 6 per cent.; decreases the volume of CO discharged through stack, 10 per cent.; increases evaporation per pound of coal, 7 per cent.

These Chicago tests were run with coal from McCoupin County, Illinois, of the following composition: Fixed carbon, 37.47 per cent.; volatile matter, 38.41 per cent.; moisture, 9.89 per cent.; ash, 12.23 per cent.; B.t.u. per lb. of dry coal, 12,884. Both tests were run with a locomotive having a narrow firebox, 40 in. wide by 106 in. long, with 29 sq.ft. of grate area. The air inlet through ashpan was 5.7 sq.ft., or 20 per cent. of the grate area. The arch was 66 in. long and was supported on two arch tubes.

The final conclusions of the foregoing test report also state that "the presence of the brick arch in the locomotive firebox increases efficiency and decreases fuel consumption, decreases the loss of heat units in smoke and ash discharged and reduces the visible smoke. The use of incorrect methods of firing, as indicated by the results of tests in which inexperienced firemen were employed, reduces efficiency, increases fuel consumption and fuel losses and increases smoke discharges."

Tests recently conducted on a Mikado-type locomotive show smoke reductions varying from 50 per cent. at low and medium rates of firing to 31 per cent. at high rates. The locomotive was hand-fired, using high-volatile Pennsylvania gas coal screened over a 1¼-in. mesh screen; the coal having the following composition: Fixed carbon, 54 per cent.; volatile matter, 31 per cent.; moisture, 0.92 per cent.; ash, 14.08 per cent.; B.t.u. per lb. of dry coal, 13,088. This locomotive had 70 sq.ft. of grate area; a barrel combustion chamber 42 in. long; a 76-in. arch supported on four 3-in. arch tubes; an air opening through ashpan of 7.80 sq.ft. (or 11 per cent. of the grate area) and air openings in grate of 20.21 sq.ft. (or 28.8 per cent. of the grate area).

In these tests the increase in evaporation, due to the arch, varied from 8½ to 15½ per cent. These three tests are probably the most thorough and reliable that have ever been conducted for the specific purpose of determining the effect of a brick arch on locomotive smoke abatement; and the test results—a reduction in smoke of from 30 to 50 per cent.—are corroborated by the practical experience of railroad men throughout the country. The principal measures taken by railroads today to meet smoke ordinances consist of issuing firing instructions and equipping locomotives with brick arches.

The formation of smoke is due primarily to the decomposition of the volatile hydrocarbons contained in all bituminous, semibituminous and lignitic coals; though the presence of coal dust that is fed into the firebox, caught up by the draft and whirled out through the flues unburned, adds to the smoke emissions.

As the name indicates, the volatile hydrocarbons are compounds of carbon and hydrogen and are of a very complex character. The heavier compounds are driven off in the form of tar, in a semiliquid or solid state; while the lighter hydrocarbons are driven off in a gaseous state. The distilation begins at a temperature around 400 deg. F. and is completed at a temperature of 1600 deg. F. The decomposition of the volatile matter by the action of heat takes place readily at temperatures above 1400 deg. F.

The exact composition of the hydrocarbons when first distilled from the coal at the different temperatures is not known, as they break down so readily under the influence of heat and are so unstable that it is impossible to collect samples for analysis. The indications are, however, that the heavy hydrocarbons, when first driven off, contain (by weight) about 85 per cent. carbon, 10 per cent. hydrogen and 5 per cent. oxygen. Under the influence of heat, these hydrocarbons break down into carbon, hydrogen, oxygen, lighter hydrocarbons of the methane (CH_4) series and lighter unsaturated hydrocarbons.

The hydrogen, a colorless gas, is highly inflammable and burns readily if there is an oxygen supply above the fuel bed. The lighter hydrocarbons also burn readily if the oxygen supply is sufficient. If it is insufficient, the hydrocarbon is broken down by the heat into carbon and hydrogen, the hydrogen either combining with the oxygen that may be present, to form water, or escaping into the flues unburned.

Carbon does not exist in a gaseous state at temperatures with which we are familiar in furnace practice; so that when the various hydrocarbons are decomposed, the carbon is precipitated as a solid particle in the form of soot; and these incandescent particles floating in the flame give it the luminous color.

The particles of soot (resulting from the breaking down of the hydrocarbons) is well on its way to the flues at the instant of its formation. As was previously noted, it is not brought into violent mechanical contact with a supply of oxygen, but floats along in an atmosphere that has been robbed of much of its oxygen in passing through the fuel bed. The temperatures prevailing in the upper part of the firebox are sufficiently high, generally, to insure ignition and combustion; but under ordinary conditions, the time available for combustion varies from $\frac{1}{2}$ to $\frac{1}{5}$ of a second, and this is insufficient.

Soot Difficult To Burn

The small quantity of oxygen above the fuel bed; the difficulty of bringing the oxygen in contact with the soot, due to ineffective mixing and the interference of the large volumes of inert and noncombustible gases; and the short time available for combustion, make the burning of soot and the elimination of smoke in locomotive operation a rather difficult matter.

With the conditions that prevail in the locomotive firebox, it is easier to prevent the formation of soot (or smoke) than to burn it when once formed. The precipitation of soot can be prevented by having an excess of heated air (or oxygen) above the fuel bed and bringing this heated oxygen in intimate contact with the volatile hydrocarbons at the instant they are distilled off.

Research work done by the United States Bureau of Mines indicates that the hydrocarbons are decomposed when they have traveled but a few inches from the top of the fuel bed; and if the precipitation of carbon is to be prevented, the air (or oxygen) must be introduced at the top of the fuel bed and intimately mixed with the issuing hydrocarbons.

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*Abstract of paper read at convention of Smoke Prevention Association, Columbus, Ohio, September, 1917.

†American Arch Co., New York City.

The chief function of the brick arch in abating smoke is that of a gas mixer. By baffling and compelling all the gases to pass through a relatively restricted area above the arch, an intimate mixture of the volatile combustible with the oxygen is insured. While the mixing of the gases at the end of the arch does not take place soon enough to eliminate smoke entirely, it has the effect of reducing the smoke emissions, as shown by the tests quoted.

With a firebox without an arch with a characteristic fire—that is, with a bank of green coal under the fire-door, the fire gradually thinning down toward the front end of the grate, where the draft has possibly pulled a hole in it—the bank of green coal under the door is expelling large volumes of rich hydrocarbons, which, passing up along the top zone of the firebox, are decomposed by the heat, causing the formation of soot, which either escapes at the front end as smoke, or is deposited on the heating surfaces to retard the flow of heat. At the same time a large excess of air is rushing through the thin portion of the fire on the front of the grate and is passing directly into the lower flues, without in any way aiding the combustion of the hydrocarbons being distilled in the back of the box, and very often causing flue leaks or failures.

Such conditions are not at all uncommon in locomotive fireboxes unequipped with the arch. Front-end gas analyses often show a large excess of oxygen, due to the blast of air through the lower flues, in combination with high carbon-monoxide, hydrogen and hydrocarbon contents, due to incomplete combustion of the volatile hydrocarbons arising from the bank under the door.

Where the arch is provided, any excess air coming through the thin portion of the fire on the front of the grates is heated up, deflected and forced back over the end of the arch, where it is mixed with the gaseous combustibles rising from the green coal under the door. With the ordinary type of firebox, the combustion chamber space and the flameway are insufficient to give all the particles of soot and combustible gas time to burn before reaching the flue sheet; but such a mixing as the arch affords results in a material reduction of the smoke, and under moderate rates of firing will result in almost complete combustion of the combustible gases.

Firing Furnaces Having Arches

The arch, however, is not sufficient to eliminate smoke when the method of firing here described is followed. A heavy bank of green coal restricts the flow of air at the point where it is most needed and at the time when it is most needed, with the result that most of the hydrocarbons are broken down and the carbon precipitated before being brought into contact with the oxygen entering through the front grates.

A similar condition prevails where the banks cause a restricted flow of air through the fuel bed at the points where the maximum distillation of hydrocarbons is taking place.

A light, level fire should be carried if smoke is to be reduced to the minimum. With the fuel bed in this condition and a "scatter" type of firing being followed, a uniform air supply is obtained throughout the fuel bed, as well as a uniform distillation of the hydrocarbons. This facilitates the mixture of the oxygen and the hydrocarbons from the time they leave the top of the fuel bed, the arch mechanically accelerating this mixture.

Some authorities state that the decomposition of the hydrocarbons is caused by heating them up with an insufficient air supply and then bringing them in contact with the cooler heating surfaces or a draft of cold air. While later evidence tends to prove that this decomposition is caused entirely by heat, shafts of cold air through the firebox are objectionable, both from the viewpoint of combustion and that of boiler maintenance.

Where the arch is used, shafts of cold air entering through the fire-door and holes in the fire are made to mix and mingle with the products of combustion and combustible gases, thereby aiding combustion; and being brought to the temperature of the other gases are prevented from causing uneven temperatures or violent fluctuations at the flue sheet.

It is evident from the foregoing that the arch is not in itself sufficient to prevent smoke. Intelligent firing is also necessary. Smokeless firing and intelligent firing are almost synonymous, although there are conditions under which smokeless firing is impossible, regardless of the care and intelligence exercised by the firemen.

In some quarters, however, there has been prevalent an idea that smoke was mainly a nuisance and that the emission of dark clouds of smoke did not signify any appreciable heat loss. As a matter of fact, the emission of smoke not only indicates bad furnace conditions, but in many cases the soot and tar escaping as smoke may contain from 10 to 15 per cent. of the heat value of the coal; and this will account for a considerable portion of our "unaccounted-for" heat losses. Tests conducted by the United States Bureau of Mines (set forth in Technical Paper 137) showed that when burning Penn gas coal, as much as 32 per cent. of the combustible rising from the fuel bed is accounted for in the soot and tar which is the source of smoke.

In his original paper the author goes on to show the effects of the arch in different types of locomotive fireboxes and to suggest improvements in design. Several illustrations are also shown. Written discussion of Mr. Anthony's paper was presented by F. S. Deveny, of the Baltimore & Ohio R.R., Chicago, in which he corroborated Mr. Anthony and gave data on the maintenance of arches.

Negligence of Third Persons

By Chesla C. Sherlock

Prior to the enactment of the workmen's compensation acts an injured workman had one of several remedies. If he was employed by a partnership, he could sue any one or all of the partners; if he was injured by the negligence of a third person, he could sue either the third person or his employers. At the same time he was likely to find a multitude of defenses raised against him, no matter whom he might choose to bring an action against. In truth, he was like a lamb between two packs of wolves—whichever way he might turn, he was beset with a probable chance of losing his all.

The workmen's compensation acts have deprived employers of the old defense of assumption of risk and contributory negligence. In fact, wherever a rule of law was invoked by an employer or one defending an action for damages because of injuries received in the course of the employment, such rule has now been torn from the hands of the employers. In every instance the way has been made easy for the employee who has received an injury while engaged in his master's business.

But the workmen's compensation acts do not stop here, as some people have fallen into the error of thinking. They go farther and have also deprived the workmen of certain privileges and immunities which they formerly enjoyed under the old system.

Negligence of Third Person Acting Independently

Workmen are oftentimes injured through the negligence of third persons operating entirely independently of the master or the servant. The injury received by the workman is clearly within the provisions of the compensation act, and he is entitled to compensation thereunder. But has he the right, under these laws, to ignore his right of action against his employer and sue the third party, whose negligence was responsible for his injury?

Although the workman unquestionably had the right prior to the enactment of the compensation acts, he is deprived of the right under the acts. The compensation acts not only deny employers certain privileges they formerly enjoyed; they go a step farther and say that if a workman would have compensation, he must proceed in a certain way. In other words, when the law confers a right upon one, it accordingly exacts a corresponding duty—a duty to receive and enjoy the right in the spirit in which it is given. Some interesting cases which are well worth consideration have been decided on this proposition.

In a Washington case a workman was injured through the negligence of a third person. Instead of recovering compensation in the usual manner from his employer, he sought to bring an independent action against the person whose negligence was responsible for his injury. The court held that the compensation law of that state was clearly intended to withdraw the subject of compensation from all private controversy and to abolish all other means of recovery except those mentioned in the act itself.

Right here, however, we find the courts in a bitter controversy over this proposition. The Federal Circuit Court of Appeals rejected the Washington case mentioned, upon a trivial point, and held that where a workman is injured by the negligence of a third person he may proceed against such third person, even though he had no right of action against his employer.

And because of a technicality in the New York law, the court there found that the liabilities laid down in the compensation act of that state refer solely to the liabilities of the employer. The court went on to say that the act did not prevent an injured employee from seeking redress against third parties whose negligence caused his injury.

It was held in Wisconsin that notwithstanding the employer and workman were both within the provisions of the compensation act, the workman could proceed against third persons whose negligence had caused his injuries.

In New Jersey it was held that where a workman released his employer, such release did not deprive him of any right of action which he might have against a tort-feasor whose negligence had caused his injury. In a later case the court of the same state, looking at the proposition from a different point, said that the release of a tort-feasor does not operate to release the employer.

In Massachusetts an acceptance of damages from a third person prevents a workman from receiving compensation from his employer. This line of reasoning is based squarely upon the decisions of the English courts under the English compensation act. They have held in England that a workman, by the wording of their act, may proceed either against his employer or against a third person whose negligence has caused his injury. But they go on to say that a workman cannot recover damages and compensation for the same injury. The recovery of one shuts off the right to recover the other.

Indeed the Scottish court has held that where an employee had recovered compensation from his employer under an agreement that if he received damages from the third party causing his injury he would reimburse the employer, he has not "recovered compensation" so as to preclude him from proceeding against third person in an action for damages.

Under the wording of the New Jersey act an employer has no right of subrogation to the claim of a workman for damages against the tort-feasor. Nor can the employer recover the compensation he has paid to the injured employee from the tort-feasor, or the one whose wrongful act caused the injury.

English Court Decisions

In England it has been held that the employer is entitled to indemnity from the third person causing the employee's injury for which the employer was compelled to pay compensation. The employer is also entitled to indemnity from fellow-servants who caused the injury to the workman. In order, however, for the employer to recover indemnity from the third person, the liability of such third person to the workman must be proved.

The English courts have even allowed the costs of all proceedings as well as the amount of the compensation paid to be recovered against the third party, whose negligence caused the injury.

It might seem to some that the overwhelming rule of law is in favor of the converse of the proposition announced in the first of this discussion. If one looks closer at the decisions, however, he will find that they have been decided on points that do not enter into the general discussion. Some of the decisions have been harmonized because of technicalities, and others have been rendered because of the express wording of the statutes themselves.

Interpretations by the Boiler-Code Committee*

The Boiler Code Committee of the American Society of Mechanical Engineers meets monthly for the purpose of considering communications relative to the Boiler Code. Following are some recent interpretations of the committee. Copies of the Boiler Code may be purchased from the society, 29 West 39th St., New York City. For non-members the cost is 80c. per copy; for members, 40 cents.

The following interpretations were approved by the Council, Aug. 15, 1917:

Case No. 158—Inquiry: Is it permissible under Par. 331 of the A. S. M. E. Boiler Code to omit the stamping from tube heads of boiler drums where they are so flanged and corrugated that the original stamping cannot be preserved, or would it be allowable to stamp the heads with lot numbers as they come off the press so that they may be identified afterward?

Reply: It is the opinion of the committee that the construction is classed with headers and does not require the stamp to be visible after the part is formed.

Case No. 167—Inquiry: Can some allowances be made by the Boiler Code Committee in the specifications for steel castings in the Boiler Code, with regard to the chemical composition of the ladle analysis, to compensate for the difficulty at the present time in obtaining castings low in sulphur and phosphorus?

Reply: The matter of modifications in the specification for steel castings has already been referred to the American Society for Testing Materials, and the question is up for consideration at this time, but no decision has been reached.

Case No. 168—Inquiry: Referring to Case No. 113d, are we to understand that all plates forming any part of a boiler, no matter whether they are used flat, bent or flanged, either hot or cold, must be finished on all edges by either planing, milling or chipping?

Reply: The word "calking" was inadvertently omitted from the reply in Case No. 113d, and the inquiry is answered by the reply in that Case, which should read as follows:

Inquiry: (d) Is Par. 257 intended to do away with the bevel shear for finishing the calking edges of plates, and does it mean that the plate edges may only be planed, milled or chipped?

Reply: (d) According to Par. 257 of the Code, in order to eliminate the incipient cracks left by shearing, the calkng edges of the plates must be finished by planing, milling or chipping, whether they are sheared straight or beveled.

Case No. 169—Inquiry: Can a check valve where a valve stem is provided to permanently close the valve when the stem is screwed down, and thus form a combination stop and check valve, be regarded as both a stop valve and a check valve as required by Par. 317 of the Boiler Code? A device of this character is commonly applied to feed connections on one type of water-tube boiler. Is it necessary where this fitting is used on the feed connection of a boiler set in battery to provide such connection with an additional check valve and a globe valve between such check and the source of supply?

Reply: It is the opinion of the Boiler Code Committee that this combination check and stop valve should be classed only as a stop valve.

Case No. 170—Inquiry: Can stay-bolt iron made from hammered blooms consisting of wrought-iron horseshoes, be considered as meeting the requirements of the specification in the Boiler Code for stay-bolt iron, if the horseshoes are originally made from puddled iron?

Reply: It is the opinion of the committee that Pars. 139 and 140 in the specifications for stay-bolt iron require that the material forming the box pile shall consist of bars the full length of the pile. If the horseshoes which are used are first worked into the bars described in Par. 140b, then cut to the necessary full length and made into the box pile as described, the material will meet the specifications. It is essential that purchased scrap be eliminated.

*For other interpretations see "Power," Sept. 4, 1917, also Journals of the American Society of Mechanical Engineers for past several months.

Case No. 171—Inquiry: Is it essential that the 10 per cent. limit of variation allowed in Par. 285 of the Boiler Code for the springs of A. S. M. E. standard safety valves, be met where it entails serious hardship to obtain springs so close? Certain manufacturers supply only three springs for the entire range from 25 to 250 pounds.

Reply: It is the opinion of the committee that this is a matter to be taken up with the particular valve manufacturer in question, as the variation called for in the Code can be and is being met.

Case No. 172—Inquiry: (a) Is it to be understood from Par. 296 that ordinary commercial iron or steel pipe may be used from the steam space of a boiler to the upper connection of the water column and that the connection from this pipe to the steam gage may be made of copper pipe? (b) Is it permissible under Pars. 320, 321 and 322 of the Boiler Code, which require the water connections to water columns to be made of brass and provided with a cross to facilitate cleaning, to connect a drain pipe into one unused opening of the cross and insert a cast-iron plug in the other? (c) Relative to the arrangement of connections indicated in Inquiry b, is it allowable under Pars. 320, 321 and 322 of the Boiler Code to use a malleable-iron bushing and a commercial iron or steel pipe to which the drain valve may be connected?

Reply: (a) This understanding of the requirement of Par. 296 is correct. (b) The Boiler Code requires a brass connection from the boiler to the water column including the cross. Any other part can be as described in the inquiry. (c) The arrangement described would be considered as in accordance with the Code.

Electrical Means of Producing Heat

There are two ways of producing heat from electric energy—by means of resistance and by means of an arc—and heat can be produced for use by either of these methods from direct or alternating current, single or polyphase and at any commercial voltage. Hence, practically all heating devices in the market can be operated from any available source of current. Of these two methods, that of producing heat by means of resistance (aptly termed the "Joulean Effect" since it is based on Joule's Law) is almost universally employed; about the only exception is that of the use of the arc in arc welding and arc furnaces.

Moreover, due to prevalence of alternating-current supply throughout the country as well as its greater flexibility and efficiency when used over the wide range of voltages required by the various processes of application, alternating current is used in the great majority of cases. The use of the transformer with its many available taps makes possible the attainment of varying temperatures with an ease and efficiency that cannot be approached by the use of direct current, and as the heating unit load is practically noninductive and can be used in polyphase as well as single-phase circuits, the use of alternating current for this work gives a unity power factor in almost every case and possesses many advantages over direct current. For instance, in order to obtain the very low voltage used in spot welding from a direct-current supply, it would be necessary to employ a rheostat in connection with a specially wound low-voltage generator with the attendant large losses, while by the use of alternating current these voltages are readily obtained from practically any commercial supply circuit by means of the transformer.

One of the many advantages of electric heat is that it is susceptible of graduated and automatic control as to localization, time and temperature, to an extent and nicety impossible with any method of combustion. This is true whether the control be by hand or automatic, although automatic control permits of greater refinement than does hand control.

Varying heats, high, low and intermediate, are obtained with hand control by switching devices which connect the heating units or groups of units in series, in parellel or in series-parallel, much in the same manner as a four-motor street-railway equipment is handled, while if an alternating current is used, this same effect is also obtained by use of the delta-Y connection with constant voltage on the supply.

These different heats occur in certain well-defined and distinct steps according to the wattage produced by the various connections and grouping of the heating units, although in cases of small current demand, gradations between these steps can be obtained by means of a rheostat in the case of direct-current supply, and by varying the voltage on the secondary side of the transformer when alternating current is used.

In carrying on the various processes of industrial heating there is always a certain definite temperature that will produce the best results in the shortest time; which is best suited to any particular phase of the process, and it is the ability of electrically controlled units to not only meet and maintain this specific temperature to a nicety, but also to vary within a fraction of a degree with the temperature requirements of the various phases of the process, that makes the electric control stand out as superior to that employed by any method of combustion heating.—*Society for Electric Development Bulletin.*

Coal and Iron in Switzerland

The shortage of coal in Switzerland became manifest in September, 1916, according to *Commerce Reports.* A committee was established to arrange for fuel from Germany and the occupied Belgian districts, and an agreement was reached by which Switzerland was to receive 253,000 metric tons of coal and coke monthly, but the full quantity agreed upon was not delivered.

The retail prices of fuel per metric ton (2204.6 lb.) during 1916 follow:

Kinds	Retail Prices, 1916 Jan. 1	Apr. 1	Aug. 1	Dec. 1
Belgian Coal:				
Cube—				
Small lump	$12.30	$12.70	$14.00	$17.00
Large lump	13.10	13.50	15.00	18.90
Anthracite—				
Small lump	12.50	12.90	14.50	17.00
Large lump	13.50	13.90	15.40	17.60
Broken coke, all sizes	11.20	12.70	14.90	16.60
Beech charcoal	28.90	30.90	38.60	48.20

Through a commercial agreement with Germany, Switzerland hoped to relieve its economic difficulties, but did not succeed because German consignments of steel and iron were long delayed, despite contracts for immediate delivery. The consequence was the sending of representatives by several manufacturers to purchase materials in the United States; the smaller makers sent a joint representative. Satisfactory results were obtained, but many transportation handicaps were experienced. The short coal and coke supplies of the foundries were other obstacles. The prices, in short tons, at the end of 1916 were: Scrap iron, $70 to $87.60; iron in fusion, $122.60 to $176; and pig iron, $35 to $52.60, against normal quotations of $12.26 to $14, $31.60 to $38.50, and $12.26 to $14 respectively.

The German Steel Works Association created a central office for the control of prices of iron products exported to neutrals. The mark currency was canceled, a standard fixed for the franc, and contracts with the various Swiss factories were declared void, causing an advance in price of 60 per cent. Later a compromise was reached through which the contracts were to be respected and the stipulated price of the mark was to be computed at the normal rate of exchange of each country, leaving the rise in price at about 25 per cent. Iron for construction purposes came from Germany in considerable quantities until June, 1916, after which shipments became fewer and prices increased as much as 300 per cent. The quantities of wrought iron, in metric tons, imported into Switzerland during the last four years were: In 1913, 37,110; in 1914, 28,780; in 1915, 23,820; and in 1916, 22,540. The trade in pig iron assumed a new aspect after the United States became the principal country of supply. None could be imported from Germany for the period from July to November, 1916, and Switzerland was obliged to resort to the American market. In December importation from Germany was resumed and prices were demanded corresponding to the cost of American pig iron. The prices per metric ton were: January, $18.70; April, $21.85; May, $23.50; and December, $54.

Rules for Locomotive Inspection Amended

At a general session of the Interstate Commerce Commission, held in Washington on Sept. 20, the rules and instructions for the inspection and testing of steam locomotives and tenders in accordance with the Act of Feb. 17, 1911, amended Mar. 4, 1915, were further amended on account of the present international crisis, and were agreed to by the representatives of the carriers, the employees and the chief inspector, and made effective at once, to continue in force during the period of the war, except where otherwise specifically stated, as follows, except where conditions are such that the safety of operation is adversely affected thereby:

Rule 2: The lowest factor of safety for locomotive boilers which were in service or under construction prior to Jan. 1, 1912, shall be 3.25. Effective six months after the close of the war, the lowest factor of safety shall be 3.5. The dates on which factors of safety from 3.5 to 4, as provided in Rule 2, become effective, shall be advanced for a period equivalent to the duration of the war.

Rule 10, Flues To Be Removed: All flues of boilers in service, except as otherwise provided, shall be removed at least once every four years, and a thorough examination shall be made of the entire interior of the boiler. After flues are taken out, the inside of the boiler must have the scale removed and be thoroughly cleaned. This period for the removal of flues may be extended upon application if an investigation shows that conditions warrant it.

Rule 16: The date for removal of lagging for the purpose of inspecting the exterior of locomotive boilers as provided by Rule 16, except where indication of leaks exists, shall be advanced for a period equivalent to the duration of the war.

Rule 23, Method of Testing Flexible Stay-Bolts with Caps: All flexible stay-bolts having caps over the outer ends shall have the caps removed at least once every two years, and also whenever the United States inspector or the railroad company's inspector considers the removal desirable in order to thoroughly inspect the stay-bolts. The firebox sheets should be examined carefully at least once a month to detect any bulging or indications of broken stay-bolts. Each time a hydrostatic test is applied, the hammer test required by Rules 21 and 22 shall be made while the boiler is under hydrostatic pressure not less than the allowed working pressure, and proper notation of such test made on form No. 3.

Welding by Electricity

In spot-welding the material is placed between copper die points supported on the ends of two arms, and the points are brought firmly together on the metal by the use of either foot or motive power. The current is then turned on. Copper being a good conductor, provides an easy path for the flow of the current, which, however, must pass through the metal to be welded to complete the circuit. This metal is a poor conductor, and in attempting to carry the large volume of current, becomes heated, and when heated to a sufficient degree, pressure is applied either by hand, foot or automatically, and the weld completed. The principle is shown diagrammatically in the accompanying cut.[1]

In case of automatic control, the current is turned on and off and the necessary welding pressure automatically applied by the controlling mechanism, driven preferably by a variable-speed motor. In this process the nicety of electric control is completely demonstrated. The current is applied to a certain definite spot only, and in just the quantity and for the length of time desired. On account of the intense heat and the rapidity with which it can be generated, several thousand welds per hour can be made in small, light stock, but the number for the heavier and more bulky stock is more limited on account of the time taken to adjust it in the machine and additional time necessary to complete the weld.

Butt-welding is very similar to spot-welding, except that the ends of the metal are brought in contact. This junction offering the greatest resistance to the path of the current, the abutting ends instantly begin to heat. The hotter the metal the greater the resistance becomes, with the result that the heat spreads to the adjacent parts until a uniform heat is obtained, at which time lateral pressure is applied and the weld completed.

Owing to the difference in cross-section of the metal at the junction in tee-welding, it is necessary to heat the larger piece to a bright red and then bring the other to the preheated larger piece and again turn on the current. Otherwise the piece of smaller cross-section would burn before the welding heat of the larger could be obtained.—*Society for Electrical Development, Bulletin.*

[1]See p. 206, "Electric Heating"—E. A. Wilcox.

Compulsory Interconnection of Electric-Power Plants

J. P. C. Kivlen, in a paper read before the West of Scotland branch of the Mining Electrical Engineers, gave prominence to colliery power houses, for the reason that the following conditions are generally present: (a) A poor and unsalable class of fuel is available; (b) when worked in conjunction with the production of iron and steel, large power plants are installed; (c) the power houses are as modern, reliable and as well supervised as those of supply companies; (d) power is produced as cheaply as in large municipal or public power companies' stations; (e) in areas where coal and iron form the staple industries, such power houses are adjacent to the supply companies' lines; (f) cost of interconnecting would not be excessive; (g) reserve plant equivalent to the total load is often installed for the purpose of insuring continuity of supply. He did not hesitate to say that he thought it desirable for the Government to enforce delivery of surplus energy by large power producers, having no license or provisional order, to authorized distributors operating under license or order, such powers also to apply in a reciprocal sense to the supply companies. Further, he considers that before addition is made to any generating plant now in existence it should be certified for by a board of expert engineers appointed by the Government. In the case of a new power plant for public supply, the deciding of the best position for installing such plant should be left to expert engineers and the owners of the site selected should be made to sell at a reasonable valuation.—*The Practical Engineer (London).*

Another Free School for Engineers

A third four-weeks' school for marine engineers was opened on request of the Government by the University of Washington College of Engineering on Oct. 3. The success of two previous schools, the numerous applications for another course and the arrival, even from distant points, of men who came too late for the September school, have made the October course desirable. Moreover, present plans provide for a November school as well. The purpose of the course is to provide more engineers for the new American merchant marine service. Instruction is free. Prof. E. O. Eastwood is director of the school.

At the finish of the course the men go up for examination before the steamboat inspector of the Port of Seattle. The examination is in large degree theoretical. It is for this that the college course appears to forearm particularly. Men who have been away from books and propositions a long time compute more slowly or with less accuracy.

Thirty-one men completed the July school; 26 finished the September school. Between 15 and 20 is Professor Eastwood's estimate for October. Fewer men are available all the time, and the season now is less favorable. During December, January and February, when there are usually more Alaskan ships in port, the school may be taxed to capacity again, if the course is kept up.

Ambition alone does not admit to the course. The formerly rather severe qualifications have been reduced, however, because of the exigency for men. Persons desirous of entering should secure eligibility tests from Prof. Eastwood.

Norwegian Concrete Ship Launched

The *Times* Christiania correspondent, says the *Engineer* (London), gives the following particulars of the launching at the Porsgrund Cement Works of the first Norwegian iron and concrete ship. The vessel, which is of 200 tons burden, was built bottom upward and, apparently, on a sort of underlying sledge or cradle which went down into the water with the vessel. The latter is reported first of all to have become detached from its cradle, then to have sunk up to a certain point, and then gradually to have righted itself. It is said that it took only three weeks to build the boat and that the next vessel will only require about half that time.

Italy Fixes Maximum Prices of Coke

The *Gazzetta Ufficiale*, published at Rome, according to *Commerce Reports*, contains a decree of the Minister of Industry, Commerce and Labor concerning the maximum selling price for gas coke, as follows: (a) Coke, large, 280 lire ($54.04) per ton; (b) powdered, with mesh, 293.50 lire ($56.65); (c) nut coke, 152 lire ($29.34); (d) coke, bulk cargoes without mesh, 255 lire ($49.21); with a moderate superprice for the sale and delivery in their territory, in accordance with a decree of Oct. 26, 1916. Persons selling gas coke at prices higher than those established, plus any communal superprice that may be fixed, will be fined 200 or 300 per cent. of the entire price received. Repeated offense will render the offender liable to one year's imprisonment in addition. In case a dealer or producer refuses to sell gas coke at the established maximum prices, the prefect, or if necessary the syndic, may sequester the goods and cause them to be sold at the expense of the holder, reserving, however, the amount necessary for his own consumption.

To Supplement Natural Gas

Several manufacturing plants of Columbus, Ohio, that have been depending upon the natural-gas supply for operating their plants are preparing to avoid being caught in a gas shortage such as they experienced last winter. The Jeffrey Manufacturing Co. is putting in a plant to produce fuel gas from coal and it is expected to be completed about Nov. 1, at a cost said to be about $50,000.

The Federal Glass Co., one of the companies hardest hit by the gas shortage last winter, has also put in a producer plant and is building an immense concrete reservoir to store 300,000 gal. of crude oil to be used as fuel in tempering the glass. The gas producer will be used in the manufacturing operations.

The Buckeye Steel Casting Co. did not suffer much last year because it had a producer plant in operation, anticipating a natural-gas shortage. The producer plant is being enlarged this year.

Coal Shortage in the Netherlands

In order to conserve coal supplies, the city gas pressure in The Hague will be reduced between the hours of 4 and 9 p.m. each day to such an extent that it will not be usable for warming and cooking purposes, according to *Commerce Reports*. Many industries will be seriously hampered. The director of the Royal Coal Distribution Bureau has directed all street-railway companies to reduce their coal consumption (for the generation of electricity) to 75 per cent. of their July figures. Several steam tram lines have been directed to reduce their schedules considerably, and one has been required to suspend all its operations. Several mills and factories have or are about to be closed down for lack of fuel.

Miscellaneous News

Research on Cylinder Lubrication, under both steam- and gas-engine conditions, is expected to be undertaken by Professor Flowers, of Ohio State University. Apparatus especially designed for this investigation has been built. This is one of the activities of the Research Committee of the American Society of Mechanical Engineers.

The City Council of Jacksonville, Fla., has authorized the city commission to spend $65,000, or as much as is necessary to equip the electric-light plant with machinery that will enable it to supply the Government with all needed power. This, and $55,000 for new equipment spent some time ago, will make an expenditure of $120,000 upon the plant during the year. The capacity of the plant will be 12,000 kw., when the new machinery is installed. The Government will need about 600 kw. for the shipyard and as much more at the camp.

Military Authorities Recently Seized the electric-light plant supplying Chillicothe, Ohio, and Camp Sherman, the military cantonment. The seizure followed an order from Chillicothe city authorities to cut off the electric-light current to Camp Sherman, if need be, in order that the city street lights might be furnished power, even though it meant no light in the scores of barracks and officers' quarters. The plant had been making an attempt to light both the city and the camp. Military authorities will now hold the local plant under guard until a high tension is completed from Columbus.

No National Electrical Week Celebration This Year—"America's Electrical Week," and its predecessor, "Electrical Prosperity Week," while they were tremendous successes and were to have been continued each year, will not be held this year because of war conditions. This decision was made after careful consideration and conferences by executives of the society with leading men of the industry. At the annual meeting the society referred the subject of the date of next Electrical week to the board of directors, who decided to hold it in the spring of 1918, the exact date to be announced later.

The Saving to Fort Wayne (Ind.) citizens generally, in the nine years' operation of a municipally owned plant has more than doubled the original investment. The lighting rate at the start was 8c. per kw.-hr. as against 10c. charged by the privately owned light plant. A few years later the maximum lighting rate was reduced to 7c. Last year the rates were fixed as follows: For the first 50 kw. a charge of 7c. per kw.-hr. was charged; over 1050 kw., 3c. per kw.-hr. When the monthly bill is $30 or over, a discount of 20 per cent. is allowed and an additional 10 per cent. when the bill exceeds $125. For motors under 10 hp. a rate of 5c. per kw.-hr. is charged for the first 50 kw. It grades down to 2c. per kw.-hr. for motors over 350 kw.-hr. The total cost of power production has been lowered each year. In 1909 the cost per unit was 4c.; in 1916 it was only 9 mills. In seven years the total operating expenses of the plant were $638,703 and the total revenue $1,016,932, making a total net profit of $379,228. These facts led early this year to application by the city to the public service commission for another one cent reduction in rates.

Engineering Affairs

Connecticut Section of the A. S. M. E.—An experiment is to be made in Connecticut with a State Section of the American Society of Mechanical Engineers. The sections at New Haven, Bridgeport and Meriden will become branches of the State Section, and branches have been organized at Hartford and Waterbury. That at Hartford was organized on Friday evening, Sept. 28, S. F. Jeter, chief engineer of the Hartford Steam Boiler Inspection and Insurance Co. and member of the Boiler Code Committee of the A. S. M. E., presiding. Dr. Ira N. Hollis, president, Dr. D. S. Jacobus, past president, and Calvin W. Rice, secretary of the society, Henry N. Sargent, of New Haven, chairman of the Executive Committee of the Connecticut State Section, and Ernest Hartford, of the secretary's office and having special charge of the sections, were present and made brief addresses. A temporary organization was effected by the election of B. W. Hanson as chairman, H. P. Maxim as vice chairman, and S. F. Jeter as secretary and treasurer. The Waterbury branch was organized on Thursday evening, Sept. 13, by the election of W. H. Bristol as chairman, E. S. Sanderson as vice chairman, and M. J. Dempsey as secretary-treasurer.

Personals

De Laney Rankine, of Niagara Falls, has been elected president of the reorganized Tonawanda Power Co., of North Tonawanda, N. Y.

V. T. Mavity, who has spent three years in electrical engineering in Central America, has been appointed instructor of electrical engineering at the University of Cincinnati.

L. R. Madison has been appointed superintendent in district B of the power-generating department of the West Penn System, Pittsburgh, Penn., succeeding H. F. Ferguson, resigned.

Herbert B. Reynolds, formerly assistant engineer in the motive-power department of the Interborough Rapid Transit Co., New York City, has been appointed mechanical assistant to the superintendent of motive power of the United Railways and Electric Co., Baltimore, Md.

A. C. Townsend, formerly assistant to the general manager of the Green Fuel Economizer Co., has resigned and accepted a position with H. R. Geiger, sales agent for power plant equipment and Moore Steam Turbine Corporation.

Trade Catalogs

Link-Belt Electric Hoists. Link-Belt Co., 39th St. and Stewart Ave., Chicago, Ill. Book No. 246. Pp. 44; 6x9 in.; illustrated.

Duplex Piston Pattern Pumps. Worthington Pump and Machinery Corp., 115 Broadway, New York. Bulletin W-308. Pp. 52; 6 x 9 in.; illustrated.

Outside-Packed Plunger Pattern Pumps. Worthington Pump and Machinery Corp., 115 Broadway, New York. Bulletin W-400. Pp. 32; 6 x 9 in.; illustrated.

Multiple Cylinder Gas Engines. The Bruce-Macbeth Engine Co., 211 Center St., N. W., Cleveland, Ohio. Bulletin No. 156. Pp. 16; 8 x 10½ in.; illustrated.

Bigelow-Hornsby Water Tube Boiler. The Bigelow Co., New Haven, Conn. Catalog. Pp. 48; 7 x 10 in.; illustrated. This is a very fine cloth-bound catalog and in addition to illustrations of typical installations, contains tables on saturated and superheated steam, etc.

THE COAL MARKET

Boston—Current quotations per gross ton delivered alongside Boston points as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Oct. 14, 1917	One Year Ago	Oct. 14, 1917	One Year Ago
Buckwheat ..	$4.98—5.20	$2.05—3.20	$7.10—7.35	$3.25—3.50
Rice	4.40—4.65	2.50—2.65	6.65—6.90	2.70—2.95
Boiler	.....	.....	.....	.....
Barley	3.90—4.15	2.20—2.35	6.15—6.40	2.35—2.60

BITUMINOUS

Prices per gross ton for Boston delivery are as follows:

	F.o.b. Mines*		Alongside Boston†	
	Oct. 14, 1917	One Year Ago	Oct. 14, 1917	One Year Ago
Clearfields ...	$2.42—3.47	$1.15—1.75	.....	$4.25—5.00
Cambrias and Somersets...	2.42—3.47	1.45—1.90	.....	4.60—5.40

Pocahontas and New River, f.o.b. Hampton Roads, is $4, as compared with $2.85—2.90 a year ago; on cars Boston price is $8.50—8.75.
*All-rail rate to Boston is $2.60. †Water coal.

New York—Current quotations per gross ton f.o.b. Tidewater at the lower ports* as compared with a year ago are as follows:

ANTHRACITE

	Circular[1]		Individual[1]	
	Oct. 14, 1917	One Year Ago	Oct. 14, 1917	One Year Ago
Buckwheat ..	$3.95—4.65	$2.75	$5.10—5.30	$2.75—3.00
Rice	3.40—3.60	2.20	3.80—4.10	2.10—2.30
Barley	2.90—3.15	1.95	3.00—3.30	1.90—1.95

Quotations at the upper ports are about 5c. higher.

BITUMINOUS

	F.o.b. N. Y. Harbor	Mine
Pennsylvania	$3.65	$2.00
Maryland	3.65	2.00
West Virginia (short rate).....	3.65	2.00

Based on Government price of $2 per ton at mine.

*The lower ports are: Elizabethport, Port Johnson, Port Reading, Perth Amboy and South Amboy. The upper ports are: Port Liberty, Hoboken, Weehawken, Edgewater or Cliffside and Guttenberg. St. George is in between and sometimes a special boat rate is made. Some bituminous is shipped from Port Liberty. The freight rate to the upper ports is 5c. higher than to the lower ports.

Philadelphia—Prices per gross ton f.o.b. cars at mines for line shipment and f.o.b. Port Richmond for tide shipment are as follows:

	Line		Tide	
	Oct. 14, 1917	One Year Ago	Oct. 14, 1917	One Year Ago
Buckwheat ...	$2.90	$1.65	$3.80	$2.55
Rice	2.40	1.00	3.40	1.90
Boiler	2.20	.90	3.30	1.80
Barley	1.90	.75	2.15	1.65

Pittsburgh—Price of steam coal per net ton f.o.b. mine, Pittsburgh district:

	Oct. 14, 1917	One Year Ago
Slack	$3.00—3.25	$2.75—3.00
Mine-run	3.00—3.25	3.25—3.75
¾-in.	3.50—3.75	3.35—3.85

Add 40c. per ton for freight charge to Pittsburgh.

Chicago—Current prices per net ton f.o.b. mines are as follows:

	Williamson and Franklin Counties	Saline and Harrisburg	West Virginia Smokeless	Springfield	Clinton and Sullivan Counties
Steam lump ..	$2.20	$2.20	$2.40	$2.20	$2.20
Lump	2.20	2.20	2.40	2.20	2.20
Egg	2.20	2.20	2.40	2.20	2.20
Nut	2.20	2.20	....	2.20	2.20
No. 1 nut....	2.20	2.20	....	2.20	2.20
No. 2 nut....	2.20	2.20	....	2.20	2.20
No. 3 nut....	2.20	2.20	....	....	....
No. 1 washed.	2.20	2.20	....	....	....
No. 2 washed.	2.20	2.20	....	....	....
Mine-run	1.95	1.95	2.15	1.95	1.95
Screenings	1.70	1.70	1.90	1.75	1.70

Hocking lump, $2.60; splint lump, $2.40.

Northern Illinois thin vein—Prepared sizes, $2.65; mine-run, $2.40; screenings, $2.15.

St. Louis—Prices pet net ton f.o.b. mines a year ago as compared with today are as follows:

	Williamson and Franklin Counties		Mt. Olive and Staunton		Standard	
	Oct. 14, 1917	One Year Ago	Oct. 14, 1917	One Year Ago	Oct. 14, 1917	One Year Ago
6-in. lump ..	$2.35	$2.00	$2.35*	$1.85	$2.35	$1.75
2-in. lump ..	2.35	2.00	2.35*	1.85	2.35	1.75
Steam egg...	2.35	2.00	2.35*	1.85	2.35	1.75
Mine-run ...	2.10	1.40	2.10*	1.30	2.10	1.20
No. 1 nut...	2.35	2.00	2.35*	1.85	2.35	1.75
2-in. screen..	1.85	1.00	1.85*	.90	1.85	.90
No. 5 washed	1.85	1.00	1.85*	.90	1.85	.90

*Strike.
Williamson-Franklin rate St. Louis, 72½c.; other rates, 57½c.

Birmingham—Current prices per net ton f.o.b. mines are as follows:

	Mine-Run	Lump and Nut	Slack and Screenings
Big Seam	$1.90	$2.15	$1.65
Pratt, Jagger, Corona....	2.15	2.40	1.90
Black Creek, Cahaba ...	2.40	2.65	2.15

Government figures.

[1]Individual prices are the company circulars at which coal is sold to regular customers irrespective of market conditions. Circular prices are generally the same at the same periods of the year and are fixed according to a regular schedule.

PROPOSED CONSTRUCTION

Ariz., Snowflake—Stockholders of Snowflake and Taylor Irrigation Co. plan to organize a company with $50,000 capital stock to construct an electric-lighting plant to serve the two towns.

Wash., D. C.—Bureau of Supplies and Accounts, Navy Dept., Washington, soon receives bids for furnishing under Schedule 1503 at Navy Yard, Puget Sound, Wash., 13,500 ft. leaded and armored interior communication cable, 200,000 ft. plain bell wire, 36,000 ft. single-conductor lighting and power wire.

Fla., Jacksonville—City plans to equip its electric lighting plant with all the machinery necessary. Estimated cost, $65,000.

Ga., Soperton—City plans an election Oct. 24 to vote on a $10,000 bond issue for the erection of an electric-light plant. Address the Mayor.

Ill., Lyons—The Inter-Ocean Refining Co., 322 South Michigan Ave., Chicago, recently purchased a tract of land near here and plans to build a power house, stills, filter house, etc. Estimated cost, $325,000.

Kan., Caldwell—City will receive bids about Oct. 16 for the installation of a power house and reservoir. Burns and McDonnell, 400 Interstate Bldg., Kansas City, Engr.

Kan., Hellier—The Greenough Coal Co., Uniontown, Penn., will build a 1-story, 45 x 70-ft. power house here.

Ky., Louisville—R. C. Whayne Supply Co., 318 West Main St., is in the market for a second-hand 8- to 12-ton electric hoist, 220-volt, 3-phase, 60-cycle, to hand from trolley and to be of standard make, in good condition.

N. J., Jersey City—The City Commissioners will receive bids for additions and improvements to the power plant at the City Hospital until Oct. 23.

N. Y., Buffalo—The International Railway, Ellicott Sq., has had plans prepared for the erection of a substation on Military Rd. Estimated cost, $7000. G. W. Dunlap, Supt.

N. Y., Lockport—The Board Supervisors of the Tuberculosis Hospital Building Com. plan to erect an electric-light plant.

N. Y., New York—Bureau of Supplies and Accounts, Navy Dept., Washington, soon receives bids for furnishing under Schedule 1505 at Navy Yard, Brooklyn, 4000 ft. armored interior communication cable, 9000 ft. single covered bell cord, 20,000 ft. conducting copper cord, 75,000 ft. silicon bronze aërial wire. Under Schedule 1504: 150,000 ft. lead-covered, rubber-insulated wire, 77,000 ft. stranded rubber-covered, single conductor wire and 125,000 ft. twisted telephone wire.

N. Y., New York (Borough of Manhattan)—The Ice Manufacturing Co., 1480 Broadway, is having plans prepared by Mortensen & Co., Archs., 405 Lexington Ave., for a 1-story, 15 x 20-ft. brick transformer station at East 32nd St.

N. Y., Portland Point—Cuygo Power Co., 872 Broadway, New York City, plans to build a power-plant addition here. Estimated cost, $15,000.

Ohio, Cincinnati—City will receive bids until Oct. 16, for the installation of an electric-lighting system on Pike, Vine, 8th and 4th Sts. F. Krug, City Engr.

Ohio, Cincinnati—The National Lead Co., 659 Freeman Ave., plans to build a power plant in connection with other improvements.

Okla., Towson—W. S. McKenney has been granted a franchise to construct, equip and operate an electric light and power system here. T. E. Hopson, Pres.

Okla., Tuttle—R. S. Landrum has been granted a franchise to erect, maintain and operate an electric-light plant to furnish light to the town.

Penn., Scranton—The Maccar Truck Co., Cliff St., plans to build a 1-story, 30 x 42-ft. power plant in connection with its new plant on Providence Rd. and Gilligan St. Estimated cost, $10,000. P. Q. Sylvester, Pres.

Wash., Tacoma—The Chicago, Milwaukee & Puget Sound Railway Co. plans to erect a power substation for its electric line between here and Othello. Estimated cost, $160,000.

Wis., Ashland—The Ashland Light, Power and Street Railway Co., 212 West 2nd St., plans to build a 1200-hp. hydro-electric plant on the falls at the mouth of the Montreal River. Estimated cost, $100,000. F. R. Winders, Gen. Supt.

Wis., Oshkosh—Oshkosh Gas Light Co., 123 Main St., is having plans prepared by W. Baehr, Engr., 122 South Michigan Ave., Chicago, Ill. for a 90 x 100-ft. addition to its electric-light plant. W. Wallen, Gen. Mgr.

Ont., Alvinston—The Town Council plans to install an electric-lighting system. George A. McCubbin, 135 King St., Chatham, Engr.

Ont., St. Catherine—The Packard Electric Co., Race St., plans to purchase power squaring shears to cut No. 10 gage steel up to 24 in. wide.

Ont., St. Mary—Town Council plans to erect a 1-story, cement-block addition to its power plant; also purchase a water-works pump. Estimated cost, $20,000. W. Weis, Mayor.

Ont., Weston—The Weston Water, Power and Light Comn. plans to increase the capacity of its substation by installing three 100-kw. transformers in place of the 50-kw. transformers used at present.